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TABULAR PRESENTATION OF SUPERSONIC FLUTTER TRENDS FROM PISTON THEORY CALCULATIONS

WARREN H. WEATHERILL
GARABED ZARTARIAN

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

JANUARY 1958

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(2)

WRIGHT AIR DEVELOPMENT CENTER

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WRIGHT AIR DEVELOPMENT CENTER
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UNITED STATES AIR FORCE
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FOREWORD

This note, which presents results from parameteric flutter studies on a typical section airfoil using piston theory, was prepared by the Aeroelastic and Structures Research Laboratory, Massachusetts Institute of Technology, Cambridge 39, Massachusetts, for the Aircraft Laboratory, Wright Air Development Center, Wright-Patterson Air Force Base, Ohio. The work was performed at the MIT under the direction of Professor Holt Ashley and supervised by Mr. G. Zartarian and Mr. W. H. Weatherill. The research and development work was accomplished under Air Force Contract No. AF33(616)-2482, Project No. 1370, "Aeroelasticity, Vibration and Noise", and Task No. 13478, "Theoretical Supersonic Flutter Studies". Mr. Walter J. Mykytow of the Dynamics Branch, Aircraft Laboratory is task engineer. This note contains data only and represents a part of a research program on the flutter of aircraft structures at supersonic speeds. Further reports will be published as the research continues. The basic research was started 1 July 1954 and is continuing. As part of this research WADC Technical Report AD-110591 56-97, (Confidential Report - Unclassified Title) "Theoretical Studies on the Prediction of Unsteady Supersonic Airloads on Elastic Wings" has been published in two separate parts. Part I, (Unclassified Title) "Investigations on the Use of Oscillatory Supersonic Aerodynamic Influence Coefficients" which presents the studies on the use of the aerodynamic influence coefficient method, was issued in December 1955; AD-110592 and Part II, (Unclassified Title) "Rules for Application of Oscillatory Supersonic Aerodynamic Influence Coefficients" which presents working rules and recommendations for flutter analysis using the aerodynamic-influence-coefficient method, was issued in February 1956.

FOREWORD (Continued)

The authors are indebted to Professor Holt Ashley and Dr. P. T. Hsu for their contributions to the research. Also, acknowledgements are due to Mrs. Ruth Lyon and her computing group for their help in making the necessary calculations, Mr. John McHugh for help in preparing the tables and figures and Miss Kathryn Roberts for typing the final manuscript.

ABSTRACT

An extensive set of tables is presented from binary flutter calculations on the typical section airplane wing model of Theodorsen and Garrick (Ref. 1). The airloads are predicted using two-dimensional piston theory. The parameters studied include thickness as well as center of gravity position, elastic axis position, wing and aileron radii of gyration, and frequency ratio. The three binary flutter cases for which data is given are bending-torsion, bending-aileron, and torsion-aileron flutter.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

E H Schwartz
for RANDALL D. KEATOR
Colonel, USAF
Chief, Aircraft Laboratory
Directorate of Laboratories

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LIST OF SYMBOLS

a	speed of sound
b	semi-chord of wing
h	vertical displacement of elastic axis as function of t. (See Fig. 1)
$(\ )_F$	conditions at flutter
I_α	mass moment of inertia of wing-aileron combination about elastic axis per unit span
I_β	mass moment of inertia of aileron about hingeline per unit span
k	reduced frequency of simple harmonic motion
$L_1, \cdots L_6$	dimensionless coefficients defining lift on an oscillating wing
m	mass per unit length
M	free stream Mach Number
$M_1, \cdots M_6$	dimensionless coefficients defining moment on an oscillating wing
r_α	radius of gyration of wing-aileron combination referred to elastic axis ($r_\alpha = \sqrt{\frac{I_\alpha}{mb^2}}$)
r_β	radius of gyration of aileron
S_α	static unbalance of wing-aileron combination per unit span referred to the elastic axis
S_β	static moment of aileron per unit span referred to aileron hinge
t	physical time
U	free stream velocity or flight speed
w	vertical component of velocity (velocity in z-direction)

x_0	position of elastic axis referred to leading edge (non-dimensionalized with respect to 2b)
x_1	position of hingeline referred to leading edge (non-dimensionalized with respect to 2b)
x_α	non-dimensional location of cg of wing-aileron combination referred to the elastic axis ($x_\alpha = \frac{S_\alpha}{mb}$)
x_β	non-dimensional location of center of gravity of aileron referred to hingeline ($x_\beta = \frac{S_\beta}{mb}$)
α	angular displacement of wing about elastic axis as function of t. (See Fig. 1).
β	angular displacement of aileron measured with respect to α as function of time (See Fig. 1).
$\delta(x)$	thickness distribution non-dimensionalized with respect to 2b.
$\bar{\delta}$	a thickness quantity defined as $0.6\frac{t}{c}$
μ	mass density ratio defined as $\frac{m}{4\rho b^2}$
ρ	density
ω	natural frequency at flutter
ω_h	first natural bending frequency of wing
ω_α	natural torsional frequency of wing about the elastic axis
ω_β	natural torsional frequency of aileron about hingeline
χ	defined as $\left(\frac{\omega_\alpha}{\omega}\right)^2$

SECTION 1

PARAMETRIC STUDY OF FLUTTER AT HIGH SUPERSONIC SPEEDS

1. Introduction

The objective of this report is to present the numerical results of extensive binary flutter calculations on the typical section airplane wing model of Theodorsen and Garrick (Ref. 1) with two-dimensional piston theory used for the aerodynamic terms in the flutter equations. The effects of all dimensionless system parameters on the flutter eigenvalues are included.

In order to expedite publication, no graphical presentations or interpretation of results are given herein. This is therefore an interim report, designed to make the data generally available while a more complete paper is being prepared on the same subject. The final report will contain no additional numerical information but will be devoted to interpretation of findings and discussion of ways in which the material can be used.

Piston theory is an approximate technique for estimating airloads on airfoils in unsteady motion at higher supersonic and low hypersonic speeds. It had its origins in work of Hayes (Ref. 2) and Lighthill (Ref. 3) and has been applied to aeroelastic problems in several recent publications (e.g., Refs. 4 and 5). Its use for typical section flutter analyses is desirable for several reasons. First, it yields a much simplified set of equations of motion, as compared with more conventional unsteady aerodynamic theory. In some cases the flutter determinant may even be solved in closed form. Extensive flutter calculations using piston theory can be made on any small digital computing machine, such as the Burroughs E101 which was employed in the present investigation. Second, the influence of airfoil thickness (and other nonlinear effects, if significant) can be introduced without excessive additional computational difficulty. To the authors' knowledge, this is the first parametric study of flutter which includes thickness effects. Although by no means exhaustive, the ranges of parameters covered appear to be those of general interest for the supersonic flight regime.

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In setting up the flutter problem for this report, a three-degree-of-freedom determinant was first derived for the system pictured in Fig. 1. Only the three sub-cases of binary flutter were calculated, however. Thus the tables list data only on bending-torsion, bending-aileron and torsion-aileron flutter of the typical section.

The flutter equations and their solution follow the pattern established by Garrick and Rubinow (Ref. 6). A symmetrical double-wedge airfoil shape has been chosen as typical of supersonic configurations.

Section 2 gives the computational details, while Section 3 discusses the manner of tabular presentation of data. In this latter connection, a few remarks are in order. Past convention has usually been to present compressible-flow-flutter boundaries on plots of dimensionless speed* (e.g. $U_F/b\omega_\alpha$) vs. Mach number M. On such a plot, flight of a given aircraft at a given altitude is represented by a sloping straight line through the origin of coordinates. A flutter-free condition for the given altitude occurs at any M where the actual flutter curve lies above this "altitude line". This form of presentation has the disadvantage that the airspeed is contained implicitly in both the ordinate and abscissa of the stability diagram. It has been pointed out (Ref. 6) that the flutter stability boundary can equally well be presented as a curve of $b\omega_\alpha/a$ vs. M, where a is the speed of sound at flight altitude. Flight of a given aircraft at a given altitude is then described by a horizontal straight line; no flutter occurs if this straight line lies above the actual flutter curve. Alternatively, the flutter curve can be interpreted in terms of the torsional stiffness required for safe flight of a wing of given geometry at a given speed of sound and Mach number.

It has been pointed out that the curves for various altitudes can be brought in closer juxtaposition by multiplying the ordinate $b\omega_\alpha/a$ by some power of the wing-to-air density ratio μ (thus, $\mu^{1/2}$ can be interpreted in terms of indicated rather than true airspeed). For this reason, and because μ and M always appear as the product μM in the analysis, all flutter data in the present report are given as tables of $\mu b\omega_\alpha/a$ (or $\mu b\omega_h/a$) vs. μM, each row representing the ordinates of the stability boundary for one set of dimensionless parameters.

---

*See List of Symbols for definitions of all physical quantities.

2. Development of Flutter Equations

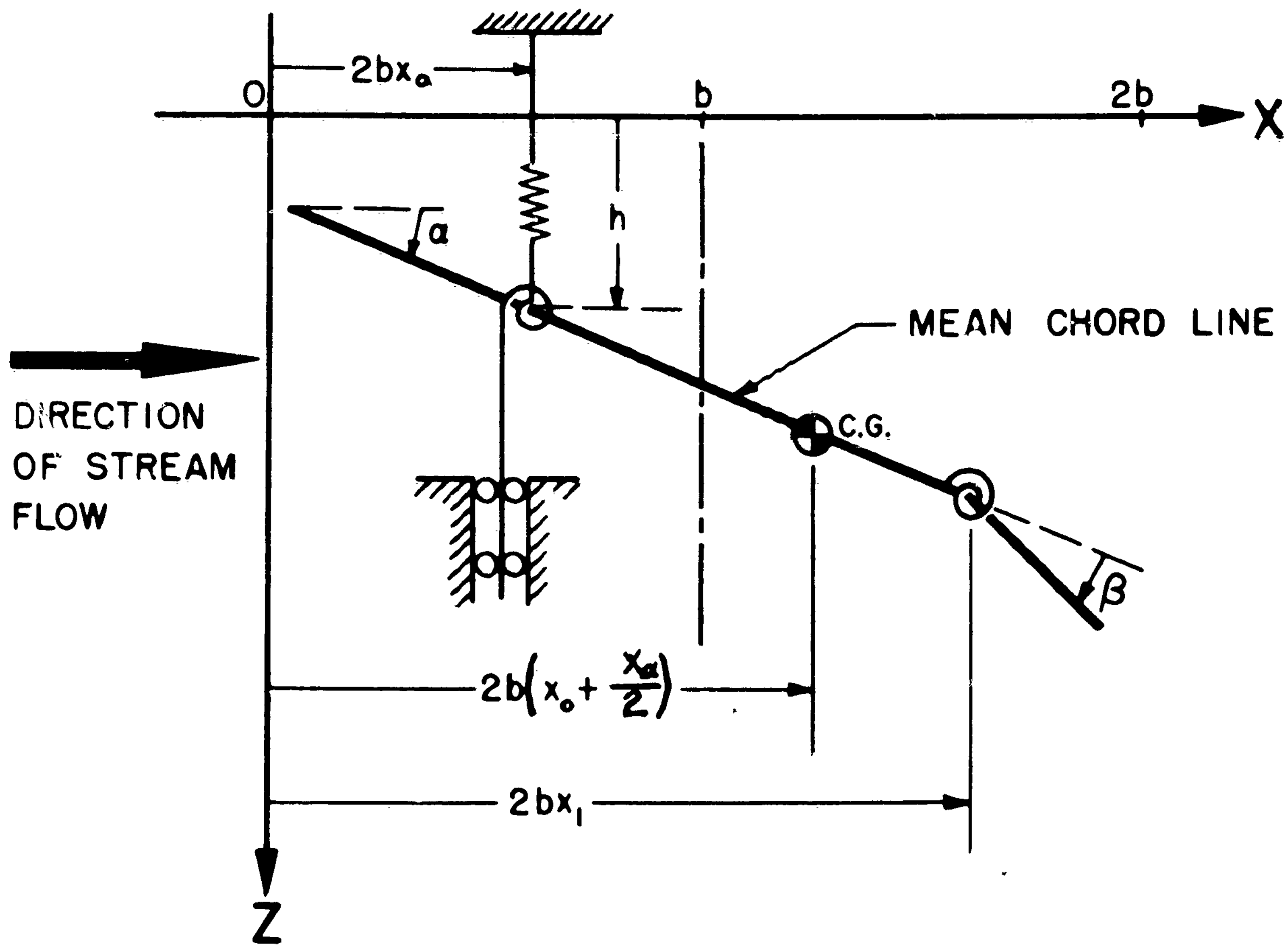
Figure 1a illustrates the two-dimensional dynamic model which forms the basis of this trend study on supersonic flutter. It is identical with the "typical section" model used by Theodorsen and Garrick (Refs. 1 and 6). This system has three degrees of freedom, described by the time-dependent quantities h, α, and β, which are analogous to bending, torsion and control-surface rotation, respectively, of an unswept wing or tail surface. When the equations of motion of this model in a supersonic airstream are set up, under the assumption that h, α, β, vary simple-harmonically with time, there results the well-known flutter determinant (cf. Ref. 6). This complex determinant, whose vanishing supplies two characteristic equations for the flutter eigenvalues U_F and ω_F, is of third order in the present example:

$$\begin{vmatrix} A & B & C \\ D & E & F \\ G & H & I \end{vmatrix} = 0 \tag{1}$$

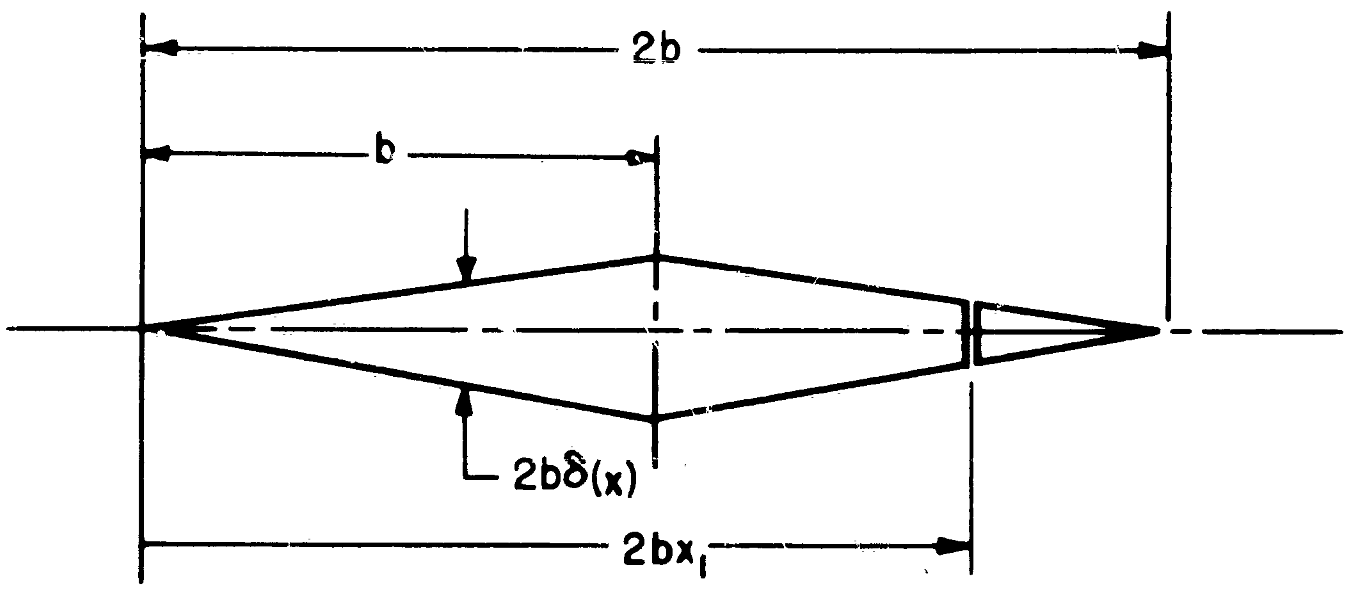
In terms of quantities defined in the List of Symbols, the elements of Eq. (1) are the following:

$$
\begin{aligned}
A &= \mu\left\{\left(\frac{\omega_h}{\omega_\alpha}\right)^2 \chi - 1\right\} + L_1 + iL_2 \\
B &= -\mu x_\alpha + L_3 + iL_4 \\
C &= -\mu x_\beta + L_5 + iL_6 \\
D &= -\mu x_\alpha + M_1 + iM_2 \\
E &= \mu r_\alpha^2\left\{\chi - 1\right\} + M_3 + iM_4 \\
F &= -\mu\left[r_\beta^2 + 2(x_1 - x_0)x_\beta\right] + M_5 + iM_6 \\
G &= -\mu x_\beta + N_1 + iN_2 \\
H &= -\mu\left[r_\beta^2 + 2(x_1 - x_0)x_\beta\right] + N_3 + iN_4 \\
I &= \mu r_\beta^2\left[\left(\frac{\omega_\beta}{\omega_\alpha}\right)^2 \chi - 1\right] + N_5 + iN_6
\end{aligned}
\tag{2}
$$

Here ($L_1 + iL_2$), etc., are dimensionless representations of the lifts, pitching moments and control-surface hinge moments due to simple harmonic motions in the three degrees of freedom. The definitions adopted here coincide with those originally given by Garrick and Rubinow (Ref. 6). For sufficiently high supersonic



(a) DYNAMIC MODEL OF AIRFOIL SECTION



(b) GEOMETRICAL SHAPE OF AIRFOIL SECTION

Fig. 1 The Model Used For Flutter Analysis

flight Mach number M, these coeffients can be put into the relatively simple forms yielded by piston theory (Ashley and Zartarian, Ref. 5). Assuming a symmetrical double-wedge airfoil section of chord 2b and thickness ratio δ , and accounting for the second-order effect of thickness, Zartarian, Heller and Ashley (Ref. 4) give the following:

$$
\begin{aligned}
L_1 &= 0 \\
L_2 &= \frac{1}{kM} \\
L_3 &= \frac{1}{Mk^2} \\
L_4 &= \frac{1}{Mk}\left\{(1-2x_0) - \mu M\bar{\delta}\right\} \\
L_5 &= \frac{(1-x_1)}{Mk^2}\left\{1-2\mu M\bar{\delta}\right\} \\
L_6 &= \frac{(1-x_1)^2}{Mk}\left\{1-2\mu M\bar{\delta}\right\} \\
M_1 &= 0 \\
M_2 &= \frac{1}{Mk}\left\{(1-2x_0) - \mu M\bar{\delta}\right\} \\
M_3 &= \frac{1}{Mk^2}\left\{(1-2x_0) - \mu M\bar{\delta}\right\} \\
M_4 &= \frac{1}{Mk}\left\{\frac{1}{3} + (1-2x_0)^2 - 2(1-2x_0)\mu M\bar{\delta}\right\} \\
M_5 &= \frac{(1-x_1)\left[(1-2x_0)+x_1\right]}{Mk^2}\left\{1-2\mu M\bar{\delta}\right\} \\
M_6 &= \frac{(1-x_1)^2\left[(1-2x_0)+\frac{2}{3}x_1+\frac{1}{3}\right]}{Mk}\left\{1-2\mu M\bar{\delta}\right\} \\
N_1 &= 0 \\
N_2 &= \frac{(1-x_1)^2}{Mk}\left\{1-2\mu M\bar{\delta}\right\} \\
N_3 &= \frac{(1-x_1)^2}{Mk^2}\left\{1-2\mu M\bar{\delta}\right\} \\
N_4 &= \frac{(1-x_1)^2\left[(1-2x_0)+\frac{2}{3}x_1+\frac{1}{3}\right]}{Mk}\left\{1-2\mu M\bar{\delta}\right\} \\
N_5 &= \frac{(1-x_1)^2}{Mk^2}\left\{1-2\mu M\bar{\delta}\right\} \\
N_6 &= \frac{4(1-x_1)^3}{3Mk}\left\{1-2\mu M\bar{\delta}\right\}
\end{aligned}
\tag{3}
$$

As in Ref. (1), the present report concentrates on the influence of various system parameters on solutions of the flutter determinant "Eq (1)" for the sub-cases obtained by successively suppressing each of the degrees of freedom. The determinants for these three binary flutters are

(1) **Bending - torsion flutter:**

$$\begin{vmatrix} A & B \\ D & E \end{vmatrix} = 0 \qquad (4)$$

(2) **Bending-aileron flutter:**

$$\begin{vmatrix} A & C \\ G & I \end{vmatrix} = 0 \qquad (5)$$

(3) **Torsion-aileron flutter:**

$$\begin{vmatrix} E & F \\ H & I \end{vmatrix} = 0 \qquad (6)$$

It is significant that the bending-torsion sub-case can be solved explicity for the dimensionless speed and frequency of flutter:

$$\frac{U_F}{b\omega_\alpha} = \mu M \sqrt{\frac{x_\alpha^2 - \left[\left(\frac{\omega_h}{\omega_\alpha}\right)^2 \chi - 1\right]\left[\chi - 1\right] r_\alpha^2}{\left(\mu M \left\{(1-2x_0-\mu M\bar{\delta})\left[\left(\frac{\omega_h}{\omega_\alpha}\right)^2\chi - 1\right] + x_\alpha\right\} + (\mu M\bar{\delta})^2 - \frac{1}{3}\right)\chi}}$$

$$\chi = \frac{r_\alpha^2 - 2x_\alpha(1-2x_0-\mu M\bar{\delta}) + \left[\frac{1}{3} + (1-2x_0)^2 - 2(1-2x_0)\mu M\bar{\delta}\right]}{r_\alpha^2 + \left(\frac{\omega_h}{\omega_\alpha}\right)^2\left\{\frac{1}{3} + (1-2x_0)^2 - 2(1-2x_0)\mu M\bar{\delta}\right\}} = \left(\frac{\omega_\alpha}{\omega}\right)^2$$

These expressions display explicity the influence of the various system parameters and combinations thereof on the eigenvalues. It is unfortunate that similar closed-form solutions cannot be written down for the other two binary flutter cases. From the computational standpoint, however, the implicit equations yielded by the bending-aileron and torsion-aileron determinants can be solved for speed and frequency with nearly equal ease.

3. Description of Results

The combinations of parameters used for each binary flutter solution are listed in Tables 1-3.

Tables 4 through 62 contain all the calculated results. Blank spaces indicate that no calculations were made. Asterisks indicate that careful examination of the equations shows that no

solutions exist. Dashes in the boxes mean that calculations were made and no real solutions were found.

The numbers contained in the tables, as mentioned in the Introduction, are values of $\mu b\omega_\alpha/a$ at flutter for the particular combination of parameters involved. The tables are setup with the purpose of making curves of $\mu b\omega_\alpha/a$ versus μM for a series of values of thickness ratio with other parameters fixed. $\mu b\omega_\alpha/a$ was chosen because, for a given configuration (values of b, ω_α and m fixed) and altitude, $\mu b\omega_\alpha/a$ is represented by a straight horizontal line in a graph of $\mu b\omega_\alpha/a$ versus μM. Also, a flight diagram showing the design capabilities of a particular aircraft may be superimposed on a plot of $\mu b\omega_\alpha/a$ versus μM. The Mach number, M, always appears in linear combination with μ, thus μM was considered to be the most convenient and economical scale for the abscissa (ef. Eq. 7). Note that μ also appears with the thickness parameter in the single combination δ/μ. An example of drawing a flutter boundary on a flight diagram is given in the Appendix. Although the tables are set up to be used to show trends due to thickness, the reader should have no trouble in combining any set of numbers to illustrate desired trends.

All the results were obtained for a typical section of a symmetrical double wedge airfoil section of chord 2b and thickness $2\delta b$. For the modes used in this report (first power in x only), as shown in ref. 5, the actual profile of the wing enters the piston theory aerodynamic derivatives only in the form of the area of the airfoil section, the area of the flap, the first area moments of the wing and flap about their leading edges, and the thickness of the profile at the hinge line, all non-dimensionalized with respect to the semichord. If these parameters can be made numerically equal for two different profiles (say by adjusting the thickness parameter), then the two profiles would have the same aerodynamic derivatives. This may be done only for special systems for the binary cases including the aileron mode and for the ternary system where three or more of the above conditions must be satisfied. However, for the bending-torsion system, where only the area and first area-moment conditions must be satisfied, similarity rules may be found between all profiles having the same non-dimensional centroid of area location. For example, a doubly symmetric biconvex airfoil section with parabolic thickness distribution of maximum thickness $2b\,\delta_{bc}$ will have the same bending-torsion flutter boundary as the double-wedge section of this report of maximum thickness 2b $(4\delta_{bc}/3)$. This of course assumes that all other system parameters are identical. These various aspects will be further discussed in the final report.

BENDING-TORSION FLUTTER						
x_α	x_o	r_α^2	∂/μ	ω_h/ω_α	Table No.	Page No.
0	0.35	0.09	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	4	15
		0.16	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	5	16
		0.25	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	6	17
	0.4	0.09	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	7	18
		0.16	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	8	19
		0.25	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	9	20
	0.45	0.09	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	10	21
		0.16	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	11	22
		0.25	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	12	23

TABLE 1

BENDING-TORSION FLUTTER (Continued)						
x_α	x_o	r_α^2	δ/μ	ω_h/ω_α	Table No.	Page No.
0	0.50	0.09	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	13	24
		0.16	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	14	25
		0.25	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	15	26
0.1	0.35	0.09	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	16	27
		0.16	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	17	28
		0.25	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	18	29
	0.4	0.09	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	19	30
		0.16	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	20	31
		0.25	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	21	32
		0.36	0	0- 0.7	22	33

TABLE 1

BENDING-TORSION FLUTTER (Continued)						
x_α	x_o	r_α^2	δ/μ	ω_h/ω_α	Table No.	Page No.
0.1	0.45	0.09	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	23	34
		0.16	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	24	35
		0.25	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	25	36
		0.36	0	0- 0.7	26	37
	0.5	0.09	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	27	38
		0.16	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	28	39
		0.25	0 0.000,5 0.001	0- 1.5 0- 1.5 0- 1.5	29	40
		0.36	0	0- 0.7	30	41
	0.55	0.09	0	0	31	42
		0.16	0	0	32	43
		0.25	0	0	33	44
		0.36	0	0	34	45

TABLE 1

BENDING-TORSION FLUTTER (Continued)						
x_α	x_o	r_α^2	δ/μ	ω_h/ω_α	Table No.	Page No.
0.2	0.35	0.09	0 0.000,5 0.001	0 0.7 0.3- 0.7 0.3- 0.7	35	46
		0.16	0 0.000,5 0.001	0 - 0.7 0.3- 0.7 0.3- 0.7	36	47
		0.25	0 0.000,5 0.001	0 - 0.7 0.3- 0.7 0.3- 0.7	37	48
		0.36	0	0 - 0.7	38	49
	0.40	0.09	0 0.000,5 0.001	0 - 0.7 0 - 0.7 0 - 0.7	39	50
		0.16	0 0.000,5 0.001	0 - 0.7 0 - 0.7 0 - 0.7	40	51
		0.25	0 0.000,5 0.001	0 - 0.7 0 - 0.7 0 - 0.7	41	52
		0.36	0	0 - 0.7	42	53
	0.45	0.09	0 0.000,5 0.001	0 - 0.7 0 - 0.7 0 - 0.7	43	54
		0.16	0 0.000,5 0.001	0 - 0.7 0 - 0.7 0 - 0.7	44	55
		0.25	0 0.000,5 0.001	0 - 0.7 0 - 0.7 0 - 0.7	45	56
		0.36	0	0 - 0.7	46	57

TABLE 1

BENDING-TORSION FLUTTER (Continued)						
x_α	x_o	r_α^2	δ/μ	ω_h/ω_α	Table No.	Page No.
0.2	0.50	0.09	0 0.000,5 0.001	0- 0.7 0- 0.7 0- 0.7	47	58
		0.16	0 0.000,5 0.001	0- 0.7 0- 0.7 0- 0.7	48	59
		0.25	0 0.000,5 0.001	0- 0.7 0- 0.7 0- 0.7	49	60
		0.36	0	0- 0.7	50	61

TABLE 1

BENDING-AILERON							
x_1	r_β^2	x_β	δ/μ	μM	$\frac{\omega_\beta}{\omega_h}$	Table No.	Page No.
0.8	0.001,96	0	0 0.001	40-400	0- 1.0	51	62
		0.01	0 0.001	40-400	0- 1.0	52	63
		0.014	0 0.001	40-400	0- 1.0	53	64
0.8	0.003,24	0	0 0.001	40- 400	0- 1.0	54	65
		0.01	0 0.001	40- 400	0- 1.0	55	66
		0.014	0 0.001	40- 400	0- 1.0	56	67

TABLE 2

TORSION-AILERON							
x_l	r_β^2	x_β	δ/μ	μM	$\frac{\omega_\beta}{\omega_\alpha}$	Table No.	Page No.
0.8	0.001,96	0	0 0.001	40- 400	0- 1.0	57	68
		0.01	0 0.001	40- 400	0- 1.0	58	69
	$x_o=0.4$ $r_\alpha^2=0.36$	0.014	0 0.001	40- 400	0- 1.0	59	70
0.8	0.003,24	0	0 0.001	40- 400	0- 1.0	60	71
		0.01	0 0.001	40- 400	0- 1.0	61	72
	$x_o=0.4$ $r_\alpha^2=0.36$	0.014	0 0.001	40- 400	0- 1.0	62	73

TABLE 3

$(\frac{\omega_h}{\omega_\alpha})$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	23.870
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	25.994
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	27.656
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	33.061
0.8	0	-	-	-	-	-	-	-	-	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	39.134
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	52.559
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	9.405	21.758	29.298	40.352	52.756	62.753	74.012	83.771	94.565	104.246
	0.0005	8.247	20.530	27.581	37.366	47.345	54.368	60.843	64.867	67.041	66.228
	0.001	6.929	19.245	25.773	34.140	41.200	44.252	43.201	35.244	-	-
1.3	0	12.243	16.342	19.601	24.870	31.145	36.352	42.310	47.527	53.335	58.569
	0.0005	11.928	15.783	18.750	23.311	28.250	31.823	35.153	37.221	38.301	37.787
	0.001	11.605	15.205	17.858	21.629	24.972	26.386	25.659	21.398	-	-
1.5	0	9.800	12.678	15.013	18.834	23.425	27.254	31.646	35.499	39.793	43.668
	0.0005	9.575	12.271	14.390	17.685	21.286	23.901	26.343	27.858	28.644	28.253
	0.001	9.349	11.850	13.736	16.446	18.863	19.878	19.319	16.167	-	-

$x_\alpha = 0$ $x_0 = 0.35$ $r_\alpha^2 = 0.09$

(See pages 6 and 7 for explanation of dashes and asterisks)

TABLE 4 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	19.898
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	20.843
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	22.917
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	27.653
0.8	0	-	-	-	-	-	-	-	-	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	32.794
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	44.393
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	14.786	21.557	26.660	34.683	44.058	51.762	60.527	68.175	76.669	84.312
	0.0005	14.268	20.713	25.411	32.445	39.952	45.365	50.440	53.649	55.444	54.887
	0.001	13.734	19.836	24.096	30.016	35.255	37.571	36.743	30.531	-	-
1.3	0	10.807	13.845	16.327	20.404	25.318	29.422	34.135	38.273	42.886	47.050
	0.0005	10.573	13.424	15.682	19.217	23.106	25.953	28.640	30.339	31.275	30.940
	0.001	10.334	12.987	15.003	17.929	20.579	21.739	21.223	17.872	-	-
1.5	0	8.361	10.547	12.352	15.338	18.954	21.984	25.468	28.531	31.948	35.034
	0.0005	8.192	10.239	11.878	14.462	17.318	19.415	21.395	22.648	23.335	23.083
	0.001	8.019	9.919	11.379	13.511	15.449	16.295	15.903	13.423	-	-

$x_\alpha = 0$	$x_0 = 0.35$	$r_\alpha^2 = 0.16$

TABLE 5 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_a}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	17.762
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	18.608
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	20.467
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	24.722
0.8	0	-	-	-	-	-	-	-	-	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	29.344
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	39.890
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	14.729	19.968	24.093	30.725	38.592	45.108	52.553	59.067	66.316	72.847
	0.0005	14.333	19.293	23.082	28.898	35.223	39.845	44.230	47.049	48.694	48.323
	0.001	13.927	18.591	22.014	26.902	31.334	33.352	32.727	27.474	-	-
1.3	0	9.667	12.197	14.286	17.741	21.925	25.430	29.461	33.004	36.958	40.528
	0.0005	9.477	11.853	13.758	16.767	20.107	22.573	24.924	26.437	27.313	27.094
	0.001	9.283	11.496	13.201	15.704	18.010	19.055	18.681	15.842	-	-
1.5	0	7.386	9.224	10.753	13.293	16.380	18.972	21.957	24.581	27.512	30.160
	0.0005	7.248	8.972	10.365	12.574	15.035	16.855	18.593	19.711	20.358	20.193
	0.001	7.106	8.710	9.954	11.789	13.483	14.251	13.969	11.867	-	-

$x_a = 0$ $\quad$ $x_0 = 0.35$ $\quad$ $r_a^2 = 0.25$

TABLE 6 $\frac{\mu b \omega_a}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * 15.212	* * 27.373	* * 38.498
0.3	0 0.0005 0.001	* - -	* - -	* - -	* - -	* - -	* - -	* - -	* - 15.890	* - 28.668	* - 40.342
0.5	0 0.0005 0.001	* - -	* - -	* - -	* - -	* - -	* - -	* - -	* - 17.355	* - 31.509	* - 44.398
0.7	0 0.0005 0.001	* - -	* - -	* - -	* - -	* - -	* - -	* - -	* - 20.556	* - 37.984	* - 53.713
0.8	0 0.0005 0.001	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - 23.686	* - 44.858	* - 63.732
0.9	0 0.0005 0.001	- - -	- - -	- - -	- - -	- - -	- - -	- - -	- - 29.096	- - 60.258	- - 86.972
1.0	0 0.0005 0.001	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
1.1	0 0.0005 0.001	- - -	12.672 10.037 6.451	20.573 17.700 14.293	30.799 26.321 20.921	41.672 33.872 23.540	50.245 38.246 19.570	59.793 40.791 -	68.014 40.128 -	77.066 34.311 -	85.161 18.088 -
1.3	0 0.0005 0.001	9.085 8.605 8.097	12.747 11.951 11.098	15.570 14.387 13.094	20.058 17.926 15.486	25.340 21.397 16.450	29.698 23.490 14.600	34.666 24.697 -	39.006 24.296 -	43.831 21.306 -	48.175 13.792 -
1.5	0 0.0005 0.001	7.606 7.284 6.948	10.099 9.538 8.941	12.088 11.240 10.318	15.309 13.760 11.996	19.151 16.263 12.665	22.341 17.779 11.319	25.993 18.652 2.558	29.191 18.349 -	32.753 16.153 -	35.964 10.715 -

$x_\alpha = 0$ $x_0 = 0.4$ $r_\alpha^2 = 0.09$

TABLE 7 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

(ω_h/ω_α)	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	15.212	27.373	38.498
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	13.019	23.598	33.413
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	14.259	25.955	36.782
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	17.026	31.350	44.532
0.8	0	-	-	-	-	-	-	-	-	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	19.845	37.118	52.891
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	25.479	50.277	72.357
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	9.061	15.880	20.549	27.611	35.673	42.223	49.629	56.066	63.196	69.599
	0.0005	8.032	14.540	18.673	24.374	29.809	33.066	34.983	34.459	29.996	18.240
	0.001	6.856	13.065	16.580	20.589	22.250	19.405	-	-	-	-
1.3	0	8.522	11.152	13.272	16.723	20.855	24.294	28.236	31.691	35.540	39.011
	0.0005	8.185	10.562	12.377	15.084	17.792	19.448	20.419	20.117	17.763	11.879
	0.001	7.834	9.933	11.402	13.209	13.949	12.515	3.308	-	-	-
1.5	0	6.726	8.591	10.118	12.630	15.660	18.192	21.101	23.654	26.502	29.073
	0.0005	6.489	8.166	9.468	11.430	13.407	14.618	15.328	15.102	13.367	9.067
	0.001	6.242	7.715	8.762	10.061	10.590	9.540	3.204	-	-	-

$X_\alpha = 0$	$X_0 = 0.4$	$r_\alpha^2 = 0.16$

TABLE 8 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	11.016	19.886	28.300
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	11.443	20.836	29.661
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	12.550	22.924	32.656
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	15.039	27.713	39.551
0.8	0	-	-	-	-	-	-	-	-	*	*
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	17.617	32.851	46.996
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	23.029	44.658	64.389
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	10.617	15.490	19.161	24.931	31.673	37.213	43.517	49.016	55.123	60.619
	0.0005	9.960	14.461	17.662	22.273	26.792	29.542	31.185	30.760	26.992	17.188
	0.001	9.256	13.346	16.004	19.180	20.521	18.173	-	-	-	-
1.3	0	7.807	9.984	11.764	14.691	18.220	21.169	24.556	27.529	30.845	33.838
	0.0005	7.534	9.496	11.019	13.317	15.639	17.073	17.928	17.689	15.682	10.641
	0.001	7.249	8.975	10.206	11.740	12.383	11.174	3.682	-	-	-
1.5	0	6.044	7.609	8.904	11.046	13.643	15.819	18.323	20.524	22.980	25.198
	0.0005	5.849	7.255	8.359	10.037	11.741	12.794	13.423	13.245	11.763	8.064
	0.001	5.645	6.879	7.767	8.881	9.347	8.459	3.157	-	-	-

$x_\alpha = 0$ $x_0 = 0.4$ $r_\alpha^2 = 0.25$

TABLE 9 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$(\frac{\omega_h}{\omega_\alpha})$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	10.459	18.791	26.176
	0.001	-	-	-	-	3.988	12.101	20.479	28.423	38.216	48.013
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	10.862	19.644	27.402
	0.001	-	-	-	-	3.899	12.599	21.420	29.764	40.042	50.318
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	11.691	21.494	30.085
	0.001	-	-	-	-	3.450	13.650	23.471	32.703	44.054	55.392
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	13.251	25.590	36.160
	0.001	-	-	-	-	-	15.790	28.055	39.393	53.253	67.062
0.8	0	-	-	-	-	-	-	-	-	*	*
	0.0005	-	-	-	-	-	-	-	14.208	29.707	42.533
	0.001	-	-	-	-	-	17.540	32.753	46.470	63.119	79.648
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	10.594	37.577	56.397
	0.001	-	-	-	-	-	17.903	42.280	62.233	85.811	108.961
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	-	-	-	14.355	24.632	31.740	39.264	45.562	52.381	58.408
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-
1.3	0	2.860	6.988	9.459	13.068	17.109	20.363	24.026	27.200	30.710	33.858
	0.0005	-	5.260	7.184	9.217	9.922	8.235	-	-	-	-
	0.001	-	2.562	3.711	-	-	-	-	-	-	-
1.5	0	4.026	6.216	7.815	10.294	13.163	15.511	18.175	20.496	23.071	25.386
	0.0005	3.321	5.185	6.330	7.642	8.106	6.976	-	-	-	-
	0.001	2.421	3.889	4.362	3.260	-	-	-	-	-	-

$X_\alpha = 0$ $\quad X_0 = 0.45$ $\quad r_\alpha^2 = 0.09$

TABLE 10 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$(\frac{\omega_h}{\omega_\alpha})$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	8.489	15.268	21.291
	0.001	-	-	-	-	3.235	9.830	16.665	23.172	31.234	39.344
0.3	0	*	*	*	*	*	*	*	*	*	*
	c.0005	-	-	-	-	-	-	-	8.844	15.975	22.299
	0.001	-	-	-	-	3.243	10.258	17.444	24.274	32.731	41.236
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	9.597	17.520	24.510
	0.001	-	-	-	-	3.151	11.178	19.148	26.694	36.025	45.403
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	11.154	20.993	29.549
	0.001	-	-	-	-	1.856	13.153	23.002	32.228	43.594	54.999
0.8	0	-	-	-	-	-	-	-	-	*	*
	0.0005	-	-	-	-	-	-	-	12.486	24.589	34.900
	0.001	-	-	-	-	-	15.008	27.037	38.134	51.743	65.367
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	13.350	32.128	46.900
	0.001	-	-	-	-	-	17.679	35.746	51.557	70.640	89.656
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	-	3.565	9.999	16.568	23.158	28.250	39.264	45.562	52.381	58.408
	0.0005	-	-	4.385	9.558	11.010	7.496	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-
1.3	0	4.841	7.071	8.750	11.387	14.469	17.001	19.881	22.394	25.185	27.696
	0.0005	4.157	6.004	7.188	8.568	9.061	7.863	-	-	-	-
	0.001	3.334	4.697	5.163	4.073	-	-	-	-	-	-
1.5	0	4.234	5.709	6.874	8.750	10.980	12.867	14.939	16.787	18.844	20.698
	0.0005	3.810	4.987	5.786	6.742	7.086	6.242	-	-	-	-
	0.001	3.331	4.137	4.429	3.741	-	-	-	-	-	-

$X_\alpha = 0$ $\quad X_0 = 0.45$ $\quad r_\alpha^2 = 0.16$

TABLE 11 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	7.401	13.325	18.601
	0.001	-	-	-	-	2.819	8.577	14.565	20.287	27.406	34.603
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	7.722	13.949	19.486
	0.001	-	-	-	-	2.858	8.961	15.252	21.256	28.722	36.269
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	8.410	15.313	21.428
	0.001	-	-	-	-	2.877	9.790	16.755	23.384	31.619	39.938
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	9.882	18.402	25.870
	0.001	-	-	-	-	2.395	11.606	20.173	28.260	38.281	48.391
0.8	0	-	-	-	-	-	-	-	-	*	*
	0.0005	-	-	-	-	-	-	-	11.251	21.641	30.612
	0.001	-	-	-	-	-	13.392	23.78	33.486	45.466	57.532
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	13.120	28.665	41.380
	0.001	-	-	-	-	-	16.539	31.769	45.463	62.185	78.958
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	-	7.644	11.147	15.998	21.294	25.514	30.237	34.316	38.817	42.848
	0.0005	-	4.902	7.930	10.823	11.802	9.460	-	-	-	-
	0.001	-	-	1.117	-	-	-	-	-	-	-
1.3	0	4.899	6.636	8.005	10.205	12.816	14.979	17.450	19.613	22.019	24.187
	0.0005	4.397	5.788	6.730	7.856	8.264	7.275	-	-	-	-
	0.001	3.828	4.785	5.132	4.317	-	-	-	-	-	-
1.5	0	4.011	5.210	6.181	7.767	9.670	11.256	13.074	14.669	16.446	18.049
	0.0005	3.675	4.618	5.275	6.074	6.364	5.656	1.224	-	-	-
	0.001	3.304	3.932	4.165	3.615	-	-	-	-	-	-

$x_\alpha = 0$ $x_0 = 0.45$ $r_\alpha^2 = 0.25$

TABLE 12 $\frac{\mu b \omega_\alpha}{g}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	1.439	3.247	4.733	7.502	11.511	15.466	20.710	25.939	32.465	38.984
	0.001	2.975	5.079	7.037	10.830	16.425	21.983	29.374	36.753	45.970	55.183
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	3.030	4.713	7.710	11.967	16.140	21.656	27.149	33.999	40.840
	0.001	2.707	5.094	7.213	11.248	17.151	22.996	30.757	38.502	48.171	57.835
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	2.057	4.477	8.077	12.920	17.586	23.714	29.794	37.364	44.916
	0.001	-	4.960	7.500	12.112	18.714	25.202	33.788	42.343	53.014	63.672
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	1.519	8.296	14.781	20.688	28.293	35.769	45.030	54.243
	0.001	-	3.010	7.463	13.746	22.108	30.141	40.678	51.128	64.134	77.107
0.8	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	6.891	16.117	23.599	32.944	42.005	53.158	64.210
	0.001	-	-	5.389	14.773	25.377	35.215	47.957	60.512	76.095	91.607
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	14.328	27.756	42.137	55.385	71.319	86.906
	0.001	-	-	-	11.341	30.677	45.595	64.045	81.868	103.796	125.590
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-
1.3	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-
1.5	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-

$x_\alpha = 0$	$x_0 = 0.5$	$r_\alpha^2 = 0.09$

TABLE 13 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	1.165	2.629	3.832	6.074	9.320	12.522	16.768	21.001	26.284	31.563
	0.001	2.409	4.112	5.697	8.768	13.298	17.799	23.782	29.757	37.219	44.678
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	0.678	2.561	3.886	6.286	9.717	13.088	17.549	21.993	27.536	33.073
	0.001	2.312	4.189	5.886	9.136	13.905	18.632	24.912	31.180	39.006	46.828
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	2.234	3.919	6.706	10.565	14.315	19.256	24.167	30.286	36.393
	0.001	1.876	4.282	6.251	9.917	15.222	20.455	27.392	34.309	42.941	51.565
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	3.303	7.382	12.351	17.024	23.106	29.115	36.578	44.014
	0.001	-	3.913	6.772	11.538	18.151	24.584	33.061	41.489	51.992	62.474
0.8	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	7.464	13.955	19.733	27.120	34.354	43.305	52.200
	0.001	-	0.451	6.599	12.937	21.118	28.916	39.109	49.201	61.755	74.270
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	15.674	24.807	35.673	46.018	58.641	71.103
	0.001	-	-	-	13.952	26.925	38.309	52.807	66.965	84.515	101.947
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1.1	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-
1.3	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-
1.5	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-

$x_\alpha = 0$	$x_0 = 0.5$	$r_\alpha^2 = 0.16$

TABLE 14 $\frac{\mu b \omega_\alpha}{a}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_a}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	1.014	2.287	3.333	5.284	8.107	10.893	14.587	18.269	22.865	27.457
	0.001	2.095	3.577	4.956	7.628	11.568	15.483	20.688	25.886	32.377	38.866
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	0.733	2.270	3.409	5.485	8.464	11.394	15.272	19.137	23.958	28.774
	0.001	2.058	3.670	5.139	7.960	12.103	16.214	21.675	27.127	33.934	40.738
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	2.134	3.521	5.900	9.232	12.483	16.773	21.041	26.360	31.670
	0.001	1.854	3.828	5.509	8.672	13.270	17.815	23.844	29.857	37.363	44.862
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	0.078	3.398	6.672	10.895	14.919	20.130	25.390	31.868	38.327
	0.001	-	3.857	6.163	10.197	15.891	21.458	28.812	36.130	45.255	54.366
0.8	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	2.006	7.125	12.488	17.412	23.769	30.023	37.779	45.496
	0.001	-	2.960	6.445	11.626	18.596	25.314	34.135	42.884	53.780	64.650
0.9	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	5.024	14.996	22.459	31.642	40.502	51.367	62.137
	0.001	-	-	2.822	13.638	24.219	33.876	46.313	58.541	73.721	88.804
1.0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
1:1	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-
1.3	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-
1.5	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	-	-	-	-	-	-	-
	0.001	-	-	-	-	-	-	-	-	-	-

$x_a = 0$ $x_0 = 0.5$ $r_a^2 = 0.25$

TABLE 15 $\frac{\mu b \omega_a}{a}$ **FOR BENDING-TORSION FLUTTER**

$(\frac{\omega_h}{\omega_\alpha})$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	3.609	11.946	18.260	25.656	32.859
	0.001	-	-	-	0.451	10.442	16.935	25.143	33.214	43.269	53.364
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	7.277	9.899	12.152	16.154	21.576	26.674	33.220	39.604	47.446	55.187
	0.001	7.890	10.904	13.594	18.554	25.537	32.276	41.069	49.729	60.425	71.012
0.8	0	10.657	13.593	15.999	19.959	24.739	28.734	33.322	37.351	41.846	45.903
	0.0005	11.122	14.407	17.219	22.122	28.567	34.454	41.834	48.873	57.385	65.671
	0.001	11.567	15.174	18.349	24.066	31.872	39.217	48.610	57.724	68.870	79.881
0.9	0	13.475	16.993	19.899	24.705	30.528	35.404	41.016	45.950	51.448	56.415
	0.0005	13.841	17.640	20.873	26.442	33.615	40.025	47.889	55.226	63.992	72.357
	0.001	14.194	18.255	21.782	28.014	36.288	43.861	53.315	62.257	72.932	83.333
1.0	0	15.099	18.941	22.125	27.405	33.814	39.188	45.373	50.812	56.883	62.366
	0.0005	15.373	19.424	22.851	28.693	36.086	42.564	50.346	57.470	65.713	73.385
	0.001	15.635	19.878	23.518	29.827	37.960	45.167	53.831	61.677	70.538	78.487
1.1	0	15.616	19.530	22.782	28.181	34.740	40.244	46.582	52.156	58.379	64.000
	0.0005	15.797	19.847	23.253	29.005	36.166	42.323	49.562	56.031	63.315	69.881
	0.001	15.969	20.136	23.669	29.681	37.202	43.631	51.025	57.334	63.833	68.707
1.3	0	14.650	18.263	21.271	26.274	32.358	37.468	43.353	48.530	54.312	59.535
	0.0005	14.694	18.330	21.361	26.406	32.531	37.640	43.442	48.419	53.756	58.284
	0.001	14.730	18.376	21.408	26.421	32.392	37.185	42.256	46.060	49.083	49.830
1.5	0	12.902	16.057	18.687	23.064	28.391	32.866	38.021	42.557	47.623	52.200
	0.0005	12.879	16.004	18.596	22.871	27.985	32.173	36.825	40.710	44.740	48.009
	0.001	12.851	15.936	18.474	22.595	27.354	31.017	34.662	37.102	38.472	37.546

$x_\alpha = 0.1$ $x_0 = 0.35$ $r_\alpha^2 = 0.09$

TABLE 16 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	6.993	15.186	21.958
	0.001	-	-	-	-	-	9.534	17.265	24.453	33.321	42.265
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	2.980	5.128	6.869	9,957	14.264	18.400	23.806	29.147	35.770	42.353
	0.001	3.978	6.474	8.656	12.713	18.524	24.208	31.695	39.116	48.321	57.455
0.8	0	8.269	10.679	12.638	15.844	19.699	22.914	26.603	29.838	33.446	36.701
	0.0005	8.758	11.522	13.890	18.042	23.555	28.637	35.054	41.216	48.691	55.983
	0.001	9.220	12.302	15.026	19.968	26.778	33.223	41.501	49.514	59.262	68.754
0.9	0	12.970	16.373	19.182	23.826	29.450	34.159	39.578	44.341	49.654	54.457
	0.0005	13.313	16.978	20/089	25.438	32.305	38.422	45.911	52.896	61.130	69.007
	0.001	13.643	17.548	20.932	26.886	34.748	41.914	50.807	59.173	69.138	78.762
1.0	0	16.208	20.298	23.693	29.327	36.167	41.906	48.513	54.322	60.807	66.665
	0.0005	16.415	20.662	24.235	30.281	37.838	44.372	52.117	59.116	67.119	74.496
	0.001	16.613	20.999	24.727	31.105	39.174	46.199	54.528	62.017	70.538	78.477
1.1	0	17.062	21.284	24.797	30.637	37.740	43.703	50.572	56.613	63.360	69.454
	0.0005	17.128	21.392	24.950	30.887	38.137	44.236	51.249	57.378	64.135	70.111
	0.001	17.188	21.482	25.067	31.043	38.291	44.296	51.019	56.645	62.432	66.978
1.3	0	14.578	18.114	21.064	25.979	31.964	36.993	42.789	47.888	53.585	58.731
	0.0005	14.505	17.971	20.838	25.548	31.143	35.694	40.723	44.912	49.267	52.836
	0.001	14.429	17.823	20.599	25.079	30.217	34.169	38.154	40.957	42.900	42.802
1.5	0	11.723	14.539	16.892	20.815	25.596	29.614	34.247	38.323	42.877	46.992
	0.0005	11.628	14.359	16.611	20.288	24.610	28.075	31.831	34.882	37.943	40.321
	0.001	11.532	14.176	16.322	19.739	23.553	26.367	29.006	30.577	31.038	29.346

$x_\alpha = 0.1$	$x_0 = 0.35$	$r_\alpha^2 = 0.16$

TABLE 17 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
0.5	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	-	9.519	16.479
	0.001	-	-	-	-	-	5.309	13.332	20.086	28.309	36.629
0.7	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	1.758	5.212	9.183	12.914	17.780	22.596	28.586	34.563
	0.001	-	2.812	5.057	8.819	14.084	19.229	26.031	32.811	41.279	49.754
0.8	0	6.315	8.318	9.925	12.536	15.656	18.249	21.221	23.823	26.723	29.337
	0.0005	6.856	9.230	11.264	14.858	19.685	24.185	29.918	35.462	42.223	48.842
	0.001	7.355	10.053	12.488	16.831	22.934	28.760	36.274	43.580	52.472	61.118
0.9	0	12.051	15.798	18.516	23.008	28.446	33.001	38.241	42.843	47.979	52.617
	0.0005	12.824	16.364	19.365	24.513	31.105	36.961	44.099	50.741	58.561	65.967
	0.001	13.134	16.898	20.150	25.854	33.356	40.148	48.541	56.379	65.653	74.453
1.0	0	17.181	21.488	25.065	31.005	38.222	44.278	51.251	57.383	64.230	70.415
	0.0005	17.322	21.731	25.425	31.632	39.308	45.870	53.560	60.437	68.230	75.364
	0.001	17.456	21.955	25.748	32.164	40.156	47.016	55.070	62.282	70.538	78.392
1.1	0	17.590	21.898	25.488	31.462	38.732	44.838	51.874	58.063	64.976	71.221
	0.0005	17.573	21.855	25.413	31.307	38.419	44.325	51.031	56.823	63.147	68.703
	0.001	17.552	21.806	25.327	31.123	38.030	43.667	49.917	55.148	60.636	65.233
1.3	0	13.151	16.302	18.936	23.328	28.681	33.182	38.371	42.936	48.038	52.646
	0.0005	13.058	16.127	18.664	22.821	27.739	31.716	36.086	39.702	43.436	46.470
	0.001	12.965	15.951	18.388	22.302	26.754	30.148	33.531	35.865	37.385	37.014
1.5	0	9.939	12.296	14.269	17.562	21.580	24.958	28.855	32.284	36.115	39.578
	0.0005	9.851	12.133	14.015	17.091	20.702	23.591	26.714	29.238	31.751	33.674
	0.001	9.762	11.966	13.756	16.601	19.764	22.079	24.207	25.393	25.492	23.461

$x_\alpha = 0.1$ $\quad x_0 = 0.35$ $\quad r_\alpha^2 = 0.25$

TABLE 18 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$(\frac{\omega_h}{\omega_\alpha})$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	10.331	18.557	25.845
	0.001	-	-	-	-	3.939	11.951	20.218	28.051	37.701	47.344
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	6.984	13.415	19 181	26.136	32.985
	0.001	-	-	-	4.572	11.401	17.410	25.190	32.895	42.514	52.157
0.5	0	3.316	4.789	5.905	7.664	9.723	11.417	13.345	15.027	16.896	18.578
	0.0005	4.359	6.398	8.177	11.433	16.012	20.442	26.245	31.985	39.110	46.200
	0.001	5.196	7.677	9.942	14.233	20.439	26.535	34.585	42.581	52.524	62.420
0.7	0	11.122	14.048	16.462	20.453	25.284	29.330	33.983	38.072	42.635	46.755
	0.0005	11.557	14.817	17.621	22.519	28.958	34.837	42.200	49.234	57.737	66.027
	0.001	11.974	15.545	18.701	24.391	32.166	39.490	48.885	58.034	69.276	80.435
0.8	0	14.125	17.720	20.700	25.641	31.639	36.667	42.455	47.542	53.223	58.353
	0.0005	14.487	18.367	21.680	27.400	34.782	41.401	49.556	57.209	66.353	75.169
	0.001	14.838	18.987	22.605	29.018	37.582	45.491	55.470	65.081	76.860	88.689
0.9	0	16.223	20.280	23.652	29.250	36.056	41.768	48.337	54.121	60.589	66.431
	0.0005	16.508	20.791	24.425	30.637	38.530	45.482	53.885	61.639	70.746	79.305
	0.001	16.785	21.278	25.150	31.898	40.682	48.587	58.301	67.389	78.134	88.595
1.0	0	17.072	21.296	24.811	30.654	37.760	43.726	50.598	56.643	63.393	69.491
	0.0005	17.264	21.636	25.322	31.561	39.355	46.084	54.043	61.211	69.368	76.827
	0.001	17.447	21.952	25.786	32.341	40.615	47.780	56.184	63.566	71.509	77.903
1.1	0	16.816	20.946	24.387	30.111	37.076	42.925	49.663	55.591	62.211	68.192
	0.0005	16.915	21.117	24.638	30.542	37.798	43.940	51.038	57.260	64.108	70.111
	0.001	17.005	21.265	24.843	30.847	38.181	44.269	51.005	56.407	61.267	63.464
1.3	0	14.761	18.355	21.353	26.344	32.420	37.525	43.408	48.583	54.364	59.586
	0.0005	14.740	18.306	21.268	26.164	32.034	36.853	42.220	46.709	51.362	55.114
	0.001	14.711	18.240	21.148	25.884	31.372	35.601	39.776	42.457	43.547	41.208
1.5	0	12.533	15.569	18.103	22.324	27.465	31.785	36.764	41.145	46.038	50.459
	0.0005	12.464	15.436	17.891	21.916	26.673	30.507	34.678	38.060	41.417	43.947
	0.001	12.391	15.290	17.652	21.433	25.669	28.772	31.565	32.964	32.550	28.701

$x_\alpha = 0.1$ $x_0 = 0.4$ $r_\alpha^2 = 0.09$

TABLE 19 $\frac{\mu b \omega_\alpha}{U}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	8.400	15.106	21.062
	0.001	-	-	-	-	3.201	9.726	16.485	22.917	30.880	38.885
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	8.652	13.767	19.684	25.431
	0.001	-	-	-	-	7.851	13.019	19.546	25.979	34.018	42.108
0.5	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	1.175	3.125	5.893	9.625	13.235	17.985	22.705	28.587	34.459
	0.001	1.092	3.698	5.624	9.162	14.263	19.293	25.963	32.616	40.925	49.233
0.7	0	7.822	9.979	11.746	14.655	18.164	21.098	24.469	27.428	30.729	33.709
	0.0005	8.269	10.759	12.911	16.711	21.782	26.475	32.418	38.142	45.100	51.904
	0.001	8.692	11.481	13.970	18.513	24.809	30.796	38.510	46.021	55.198	64.184
0.8	0	11.751	14.786	17.298	21.455	26.496	30.721	35.583	39.851	44.619	48.925
	0.0005	12.097	15.402	18.225	23.111	29.442	35.136	42.167	48.793	56.685	64.293
	0.001	12.432	15.985	19.091	24.612	32.009	38.842	47.456	55.706	65.686	75.449
0.9	0	15.504	19.393	22.622	27.986	34.503	39.968	46.263	51.806	57.987	63.577
	0.0005	15.763	19.854	23.320	29.233	36.726	43.306	51.245	58.561	67.116	75.207
	0.001	16.013	20.293	23.973	30.367	38.662	46.106	55.249	63.836	74.166	84.394
1.0	0	17.656	22.012	25.638	31.669	39.004	45.164	52.259	58.499	65.469	71.765
	0.0005	17.791	22.251	25.995	32.299	40.107	46.790	54.634	61.655	69.620	76.909
	0.001	17.921	22.472	26.318	32.839	40.982	47.984	56.205	63.537	71.805	79.360
1.1	0	17.400	21.649	25.191	31.088	38.265	44.294	51.241	57.352	64.179	70.345
	0.0005	17.413	21.664	25.205	31.093	38.233	44.190	50.976	56.842	63.225	68.772
	0.001	17.420	21.665	25.194	31.031	38.019	43.714	49.939	54.925	59.548	62.080
1.3	0	13.888	17.238	20.036	24.698	30.378	35.152	40.654	45.496	50.904	55.791
	0.0005	13.793	17.059	19.755	24.170	29.382	33.581	38.158	41.893	45.647	48.550
	0.001	13.696	16.873	19.459	23.598	28.251	31.700	34.917	36.733	36.869	33.617
1.5	0	10.889	13.498	15.679	19.316	23.748	27.475	31.771	35.552	39.775	43.592
	0.0005	10.781	13.297	15.366	18.731	22.653	25.756	29.054	31.646	34.104	35.813
	0.001	10.671	13.089	15.039	18.106	21.431	23.742	25.609	26.187	24.802	19.626

$x_\alpha = 0.1$ $\quad x_0 = 0.4$ $\quad r_\alpha^2 = 0.16$

TABLE 20 $\frac{\mu b \omega_\alpha}{U}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	-	7.336	13.206	18.433
	0.001	-	-	-	-	2.795	8.501	14.433	20.101	27.148	34.270
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	-	6.402	11.180	16.503	21.626
	0.001	-	-	-	-	6.176	10.866	16.684	22.405	29.568	36.805
0.5	0	-	-	-	-	-	-	-	-	-	-
	0.0005	-	-	-	2.259	6.229	9.574	13.859	18.078	23.321	28.553
	0.001	-	-	3.190	6.581	11.184	15.673	21.617	27.555	34.993	42.461
0.7	0	5.687	7.362	8.721	10.944	13.614	15.840	18.394	20.634	23.131	25.384
	0.0005	6.174	8.195	9.953	13.091	17.347	21.343	26.457	31.425	37.502	43.472
	0.001	6.623	8.946	11.038	14.905	20.341	25.562	32.333	38.953	47.059	55.000
0.8	0	9.946	12.556	14.711	18.273	22.587	26.200	30.356	34.004	38.079	41.758
	0.0005	10.287	13.158	15.614	19.878	25.428	30.443	36.652	42.516	49.522	56.265
	0.001	10.614	13.724	16.450	21.313	27.855	33.919	41.558	48.841	57.591	66.029
0.9	0	14.846	18.581	21.682	26.830	33.081	38.326	44.367	49.678	55.607	60.971
	0.0005	15.080	18.997	22.308	27.946	35.067	41.295	48.795	55.676	63.680	71.247
	0.001	15.307	19.391	22.893	28.957	36.786	43.776	52.314	60.280	69.775	79.007
1.0	0	18.137	22.602	26.319	32.503	40.025	46.343	53.620	60.022	67.171	73.629
	0.0005	18.225	22.753	26.544	32.896	40.712	47.356	55.107	62.013	69.825	76.979
	0.001	18.308	22.894	26.749	33.239	41.277	48.151	56.223	63.492	71.909	80.058
1.1	0	17.357	21.573	25.091	30.949	38.083	44.077	50.984	57.061	63.850	69.982
	0.0005	17.319	21.498	24.970	30.717	37.639	43.372	49.860	55.451	61.484	66.739
	0.001	17.279	21.418	24.841	30.464	37.134	42.534	48.433	53.211	57.824	60.807
1.3	0	12.349	15.306	17.777	21.898	26.922	31.146	36.015	40.300	45.088	49.413
	0.0005	12.247	15.116	17.482	21.349	25.896	29.539	33.481	36.665	39.818	42.195
	0.001	12.143	14.921	17.176	20.766	24.762	27.674	30.297	31.620	31.215	27.321
1.5	0	9.171	11.349	13.172	16.214	19.925	23.046	26.644	29.811	33.349	36.547
	0.0005	9.071	11.165	12.886	15.682	18.927	21.479	24.162	26.234	28.134	29.358
	0.001	8.969	10.974	12.586	15.108	17.801	19.610	20.929	21.031	18.999	12.240

$x_\alpha = 0.1$	$x_0 = 0.4$	$r_\alpha^2 = 0.25$

TABLE 21 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_a}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	*	*	*	*	*	*	*	*	*	*
0.3	0 0.0005 0.001	*	*	*	*	*	*	*	*	*	*
0.5	0 0.0005 0.001	-	-	-	-	-	-	-	-	-	-
0.7	0 0.0005 0.001	4.260	5.632	6.730	8.511	10.637	12.404	14.428	16.200	18.174	19.954
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$X_a = 0.1$	$X_0 = 0.4$	$r_a^2 = 0.36$

TABLE 22 $\frac{\mu b \omega_a}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	1.422	3.208	4.676	7.413	11.374	15.283	20.464	25 631	32.079	38.521
	0.001	2.940	5.018	6.953	10.701	16.230	21.722	29.025	36.316	45.424	54.527
0.3	0	4.369	5.673	6.729	8.453	10.523	12.247	14.226	15.960	17.894	19.638
	0.0005	5 119	6.942	8.587	11.638	15 956	20.137	25.614	31.028	37.747	44.429
	0.001	5.773	8.012	10.107	14.116	19.944	25.679	33.253	40.779	50.140	59.459
0.5	0	8.881	11.173	13.068	16.208	20.014	23.204	26.874	30.101	33.702	36.954
	0.0005	9.334	11.974	14.275	18.352	23.812	28.875	35.295	41.491	49.043	56.453
	0.001	9.764	12.723	15.381	20.257	27.044	33 526	41.920	50.142	60.261	70.255
0.7	0	14.395	17.976	20.953	25 901	31.916	36.965	42.779	47 893	53.603	58.762
	0.0005	25.742	18.601	21.904	27.616	34.997	41.619	49.785	57.484	66.696	75.610
	0.001	15.080	19.203	22.809	29.213	37.788	45.738	55.830	65.613	77.669	89.782
0.8	0	16.907	21.077	24.548	30.323	37.346	43.241	50.038	56.005	62.677	68.705
	0.0005	17.208	21.621	25.377	31.817	40.045	47.328	56.201	64.452	74.238	83.624
	0.001	17.501	22.145	26.168	33.223	42.508	50.978	61.616	71.805	84.385	97.232
0.9	0	18.367	22.871	26.624	32.866	40.462	46.848	54 201	60.679	67.884	74.412
	0.0005	18.590	23.273	27.245	33.974	42.440	49.814	58.641	66.696	76.028	84.757
	0.001	18.806	23.658	27.812	34.977	44.167	52.299	62.161	71.175	81.649	91.209
1.0	0	18.402	22.894	26.640	32.874	40.463	46.838	54.184	60.647	67.865	74.386
	0.0005	18.522	23.109	26.962	33.443	41.451	48.275	56 226	63.265	71.110	78.091
	0.001	18.635	23.302	27.242	33.897	42.123	49.062	56.901	63.367	69.431	72.462
1.1	0	17.367	21.594	25.119	30.989	38.136	44.140	51.059	57.147	63.946	70.089
	0.0005	17.393	21.635	25.175	31.069	38.223	44.185	50.943	56.721	62.871	68.003
	0.001	17.412	21.656	25.188	31.028	37.967	43.500	49.223	53.210	55.434	53.236
1.3	0	14.369	17 851	20.758	25.598	31.494	36.449	42.158	47.182	52.794	57.864
	0.0005	14.291	17.703	20.523	25.147	30.164	35.016	39.789	43.631	47.381	50.099
	0.001	14.207	17.537	20.251	24.592	29.431	32.919	35.900	37.050	35.423	28.356
1.5	0	11.813	14.668	17.052	21.023	25.862	29.927	34.614	38.737	43.343	47.504
	0.0005	11.704	14.464	16.733	20.422	24.715	28.100	31.664	34.414	36.916	38.490
	0.001	11.590	14.246	16.385	19.736	23.319	25.712	27.405	27.411	24.459	15.234

$x_\alpha = 0.1$ | $x_0 = 0.45$ | $r_\alpha^2 = 0.09$

TABLE 23 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	1.153	2.602	3.793	6.012	9.225	12.395	16.597	20.787	26.017	27.221
	0.001	2.384	4.070	5.639	8.679	13.163	17.617	23.540	29.453	36.840	44.223
0.3	0	2.710	3.625	4.351	5.524	6.920	8.078	9.403	10.563	11.855	13.019
	0.0005	3.474	4.873	6.147	8.539	11.967	15.315	19.723	24.095	29.532	34.947
	0.001	4.097	5.861	7.524	10.733	15.428	20.066	26.204	32.309	39.907	47.473
0.5	0	6.019	7.619	8.937	11.113	13.746	15.949	18.484	20.710	23.194	25.437
	0.0005	6.462	8.394	10.094	13.152	17.318	21.239	26.267	31.160	37.158	43.065
	0.001	6.874	9.099	11.125	14.896	20.224	25.364	32.057	38.632	46.730	54.722
0.7	0	11.003	13.765	16.060	19.869	24.496	28.379	32.849	36.781	41.170	45.135
	0.0005	11.320	14.332	16.917	21.406	27.239	32.499	39.008	45.156	52.512	59.614
	0.001	11.626	14.872	17.722	22.808	29.650	36.001	44.040	51.770	61.151	70.324
0.8	0	14.346	17.900	20.858	25.774	31.753	36.771	42.555	47.633	53.310	58.438
	0.0005	14.618	18.390	21.600	27.110	34.151	40.389	47.990	55.061	63.431	71.440
	0.001	14.882	18.859	22.305	28.350	36.307	43.560	52.632	61.274	71.804	82.270
0.9	0	17.440	21.723	25.291	31.226	38.450	44.516	51.503	57.658	64.523	70.746
	0.0005	17.644	22.088	25.846	32.228	40.252	47.233	55.590	63.246	72.169	80.582
	0.001	17.841	22.440	26.374	33.161	41.878	49.641	59.152	68.136	78.958	89.946
1.0	0	18.589	23.125	26.907	33.202	40.865	47.303	54.721	61.247	68.536	75.121
	0.0005	18.675	23.277	27.135	33.607	41.574	48.346	56.234	63.237	71.106	78.225
	0.001	18.756	23.417	27.340	33.947	42.113	49.051	57.064	64.025	71.456	77.362
1.1	0	17.346	21.558	25.073	30.926	38.053	44.042	50.943	57.015	63.797	69.925
	0.0005	17.317	21.501	24.979	30.740	37.677	43.410	49.860	55.340	61.153	66.010
	0.001	17.284	21.431	24.862	30.485	37.098	42.332	47.753	51.607	54.035	52.698
1.3	0	13.008	16.147	18.768	23.136	28.457	32.930	38.085	42.621	47.687	52.265
	0.0005	12.887	15.922	18.418	22.480	27.220	30.971	34.951	38.060	40.958	42.881
	0.001	12.762	15.685	18.043	21.753	25.763	28.507	30.590	30.905	28.185	18.990
1.5	0	9.921	12.306	14.298	17.619	21.666	25.068	28.990	32.441	36.296	39.780
	0.0005	9.792	12.066	13.926	16.926	20.363	23.011	25.710	27.683	29.298	30.045
	0.001	9.659	11.816	13.532	16.165	18.848	20.462	21.217	20.294	15.702	-

$x_\alpha = 0.1$ $x_0 = 0.45$ $r_\alpha^2 = 0.16$

TABLE 24 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	1.005	2.267	3.305	5.238	8.037	10.799	14.461	18.112	22.669	27.221
	0.001	2.077	3.546	4.913	7.562	11.469	15.350	20.510	25.663	32.099	38.532
0.3	0	1.919	2.656	3.229	4.143	5.223	6.115	7.133	8.022	9.012	9.903
	0.0005	2.698	3.892	4.980	7.035	9.996	12.900	16.731	20.537	25.273	29.992
	0.001	3.298	4.819	6.257	9.039	13.122	17.161	22.510	27.833	34.458	41.057
0.5	0	4.590	5.844	6.873	8.568	10.615	12.327	14.293	16.020	17.947	19.686
	0.0005	5.030	6.609	8.009	10.553	14.064	17.400	21.708	25.921	31.104	36.220
	0.001	5.434	7.290	8.996	12.201	16.773	21.209	27.007	32.713	39.749	46.693
0.7	0	8.932	11.195	13.072	16.185	19.965	23.135	26.785	29.993	33.576	36.811
	0.0005	9.236	11.735	13.886	17.637	22.543	26.992	32.522	37.761	44.042	50.109
	0.001	9.528	12.244	14.640	18.940	24.760	30.180	37.047	43.639	51.603	59.329
0.8	0	12.426	15.518	18.090	22.363	27.558	31.918	36.936	41.350	46.281	50.734
	0.0005	12.677	15.967	18.768	23.578	29.727	35.175	41.812	47.978	55.255	62.191
	0.001	12.919	16.394	19.405	24.690	31.639	37.954	45.795	53.217	62.111	70.730
0.9	0	16.576	20.652	24.048	29.696	36.568	42.340	48.994	54.832	61.383	67.267
	0.0005	16.754	20.973	24.534	30.571	38.136	44.703	52.544	59.719	68.041	75.897
	0.001	16.929	21.281	24.995	31.385	39.559	46.817	55.676	64.018	74.043	84.095
1.0	0	18.742	23.312	27.123	33.467	41.191	47.679	55.155	61.733	69.079	75.716
	0.0005	18.800	23.414	27.277	33.741	41.678	48.408	56.242	63.208	71.076	78.267
	0.001	18.856	23.512	27.421	33.991	42.104	49.026	57.134	64.401	72.705	80.471
1.1	0	16.976	21.090	24.523	30.242	37.207	43.060	49.806	55.741	62.370	68.360
	0.0005	16.920	20.985	24.360	29.935	36.625	42.136	48.320	53.568	59.143	63.828
	0.001	16.862	20.875	24.184	29.591	35.929	40.945	46.179	50.002	52.700	52.196
1.3	0	11.428	14.174	16.469	20.294	24.956	28.875	33.392	37.367	41.807	45.819
	0.0005	11.303	13.945	16.113	19.632	23.710	26.908	30.252	32.804	35.080	36.436
	0.001	11.175	13.705	15.735	18.902	22.253	24.446	25.888	25.594	21.902	8.519
1.5	0	8.260	10.235	11.887	14.641	17.998	20.821	24.076	26.940	30.140	33.031
	0.0005	8.136	10.007	11.532	13.980	16.755	18.854	20.929	22.354	23.352	23.513
	0.001	8.008	9.766	11.153	13.247	15.284	16.355	16.439	14.737	7.534	-

x_α = 0.1 | x_0 = 0.45 | r_α^2 = 0.25

TABLE 25 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	*	*	*	*	*	*	*	*	*	*
0.3	0 0.0005 0.001	1.478	2.123	2.613	3.387	4.293	5.040	5.889	6.631	7.455	8.197
0.5	0 0.0005 0.001	3.785	4.846	5.713	7.138	8.855	10.290	11.938	13.384	14.997	16.453
0.7	0 0.0005 0.001	7.648	9.601	11.218	13.899	17.153	19.881	23.020	25.781	28.862	31.645
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_\alpha = 0.1$ | $x_0 = 0.45$ | $r_\alpha^2 = 0.36$

TABLE 26 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	7.088	8.824	10.249	12.643	15.557	18.007	20.829	23.312	26.085	28.591
	0.0005	7.532	9.605	11.446	14.711	19.315	23.596	29.091	34.444	41.016	47.500
	0.001	7.952	10.336	12.525	16.618	22.424	28.041	35.381	42.619	51.573	60.454
0.3	0	8.847	10.998	12.793	15.781	19.419	22.476	25.999	29.098	32.560	35.688
	0.0005	9.236	11.696	13.848	17.669	22.780	27.508	33.492	39.257	46.273	53.149
	0.001	9.609	12.351	14.823	19.361	25.668	31.684	39.465	47.083	56.456	65.714
0.5	0	12.161	15.118	17.585	21.693	26.694	30.897	35.739	40.000	44.759	49.058
	0.0005	12.497	15.723	18.505	23.349	29.667	35.380	42.471	49.194	57.270	65.102
	0.001	12.823	16.303	19.375	24.880	32.329	39.284	48.145	56.727	67.215	77.536
0.7	0	17.105	21.264	24.733	30.511	37.546	43.456	50.267	56.259	62.953	69.000
	0.0005	17.404	21.810	25.568	32.027	40.293	47.634	56.604	65.000	74.991	34.629
	0.001	17.699	22.341	26.374	33.471	42.865	51.494	62.399	72.974	80.095	99.478
0.8	0	19.255	23.937	27.842	34.348	42.265	48.923	56.596	63.330	70.864	77.672
	0.0005	19.514	24.412	28.569	35.673	44.676	52.588	62.161	70.992	81.424	91.389
	0.001	19.769	24.874	29.273	36.936	46.920	55.972	67.237	78.020	91.302	104.880
0.9	0	20.026	24.896	28.957	35.723	43.962	50.885	58.864	65.881	73.721	80.792
	0.0005	20.196	25.206	29.430	36.578	45.491	53.179	62.257	70.464	79.808	88.387
	0.001	20.357	25.499	29.870	37.340	46.776	54.965	64.604	73.088	82.088	88.804
1.0	0	19.149	23.805	27.689	34.157	42.032	48.648	56.273	62.982	70.475	77.245
	0.0005	19.199	23.895	27.823	34.384	42.393	49.113	56.792	63.418	70.547	76.568
	0.001	19.240	23.962	27.910	34.480	42.378	48.763	55.480	60.258	63.021	60.397
1.1	0	17.319	21.531	25.044	30.894	38.017	44.002	50.898	56.966	63.743	69.866
	0.0005	17.273	21.442	24.902	30.612	37.436	43.004	49.142	54.183	59.232	63.034
	0.001	17.217	21.329	24.709	30.185	36.433	41.081	45.265	47.167	45.594	36.793
1.3	0	13.513	16.799	19.539	24.104	29.661	34.330	39.711	44.445	49.733	54.510
	0.0005	13.378	16.548	19.149	23.367	28.253	32.073	36.037	39.012	41.564	42.919
	0.001	13.235	16.276	18.714	22.504	26.468	28.971	30.381	29.490	23.873	-
1.5	0	10.754	13.369	15.550	19.182	23.605	27.321	31.603	35.370	39.579	43.381
	0.0005	10.602	13.088	15.114	18.367	22.062	24.868	27.658	29.597	31.001	31.332
	0.001	10.444	12.790	14.642	17.445	20.195	21.681	21.936	20.003	12.267	-

$x_\alpha = 0.1$	$x_0 = 0.5$	$r_\alpha^2 = 0.09$

TABLE 27 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$(\frac{\omega_h}{\omega_\alpha})$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	5.738	7.134	8.298	10.236	12.596	14.579	16.864	18.874	21.120	23.148
	0.0005	6.096	7.772	9.259	11.945	15.611	19.060	23.480	27.781	33.052	38.244
	0.001	6.433	8.358	10.124	13.423	18.093	22.601	28.476	34.255	41.386	48.438
0.3	0	6.802	8.457	9.836	12.134	14.932	17.282	19.991	22.374	25.036	27.441
	0.0005	7.131	9.044	10.723	13.717	17.740	21.475	26.214	30.786	36.354	41.810
	0.001	7.443	9.591	11.535	15.117	20.114	24.887	31.061	37.100	44.517	51.828
0.5	0	9.031	11.232	13.065	16.116	19.832	22.954	26.552	29.717	33.253	36.447
	0.0005	9.325	11.752	13.852	17.530	22.356	26.745	32.216	37.417	43.675	49.746
	0.001	9.604	12.245	14.589	18.814	24.564	29.951	36.819	43.462	51.552	59.473
0.7	0	13.384	16.639	19.354	23.874	29.379	34.004	39.333	44.022	49.260	53.991
	0.0005	13.636	17.093	20.046	25.124	31.629	37.406	44.459	51.043	58.847	66.329
	0.001	13.882	17.532	20.706	26.293	33.675	40.426	48.887	56.979	66.795	76.436
0.8	0	16.437	20.434	23.768	29.321	36.080	41.761	48.314	54.061	60.494	66.304
	0.0005	16.665	20.849	24.402	30.469	38.163	44.928	53.104	60.671	69.598	78.129
	0.001	16.889	21.252	25.013	31.563	40.109	47.845	57.505	66.735	78.093	89.590
0.9	0	18.990	23.607	27.460	33.876	41.568	48.247	55.815	62.476	69.911	76.606
	0.0005	19.158	23.916	27.929	34.731	43.241	50.611	59.402	67.402	76.741	85.497
	0.001	19.322	24.214	28.384	35.547	44.694	52.807	62.721	72.019	83.275	94.572
1.0	0	19.149	23.805	27.689	34.157	42.032	48.648	56.273	62.982	70.475	77.245
	0.0005	19.193	23.886	27.811	34.372	42.399	49.166	56.968	63.800	71.333	77.960
	0.001	19.233	23.955	27.909	34.519	42.567	49.252	56.685	62.683	68.048	70.106
1.1	0	16.943	21.063	24.499	30.222	37.190	43.045	49.791	55.727	62.357	68.347
	0.0005	16.868	20.925	24.284	29.813	36.396	41.751	47.640	52.477	57.341	61.046
	0.001	16.788	20.770	24.034	29.303	35.297	39.767	43.852	45.850	44.749	37.045
1.3	0	11.865	14.750	17.156	21.164	26.043	30.143	34.867	39.024	43.667	47.861
	0.0005	11.704	14.453	16.697	20.307	24.424	27.573	30.736	32.976	34.671	35.200
	0.001	11.537	14.140	16.201	19.340	22.468	24.225	24.693	22.765	14.576	-
1.5	0	8.727	10.849	12.619	15.567	19.156	22.171	25.646	28.703	32.118	35.203
	0.0005	8.562	10.547	12.152	14.695	17.153	19.568	21.468	22.594	23.025	22.356
	0.001	8.392	10.228	11.648	13.718	15.541	16.188	15.285	11.606	-	-

x_α = 0.1	x_0 = 0.5	r_α^2 = 0.16

TABLE 28 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	4.992 5.301 5.592	6.206 6.757 7.263	7.218 8.049 8.794	8.904 10.380 11.651	10.957 13.558 15.688	12.682 16.544 19.577	14.670 20.367 [illegible]	16.419 24.081 29.595	18.372 28.625 35.700	20.137 33.094 41.721
0.3	0 0.0005 0.001	5.762 6.053 6.329	7.164 7.683 8.166	8.332 9.117 9.831	10.279 11.676 12.902	12.649 15.122 17.191	14.640 18.327 21.288	16.934 22.394 26.581	18.953 26.320 31.748	21.208 31.097 38.083	23.245 35.776 44.310
0.5	0 0.0005 0.001	7.455 7.717 7.969	9.267 9.737 10.180	10.779 11.490 12.149	13.297 14.570 15.712	16.363 18.628 20.578	18.939 22.331 25.144	21.907 26.959 30.968	24.519 31.365 36.594	27.436 36.671 43.434	30.071 41.820 50.112
0.7	0 0.0005 0.001	11.137 11.361 11.578	13.846 14.247 14.632	16.105 16.715 17.291	19.867 20.963 21.973	24.447 26.411 28.159	28.296 31.254 33.804	32.730 37.164 40.846	36.632 42.677 47.539	40.990 49.197 55.574	44.928 55.428 63.354
0.8	0 0.0005 0.001	14.300 14.497 14.689	17.777 18.133 18.476	20.678 21.219 21.736	25.507 26.485 27.402	31.388 33.150 34.757	36.331 38.996 41.380	42.025 46.037 49.556	47.032 52.537 57.281	52.627 60.158 66.582	57.683 67.392 75.685
0.9	0 0.0005 0.001	17.940 18.089 18.236	22.303 22.573 22.840	25.941 26.356 26.762	32.003 32.756 33.490	39.381 40.750 42.077	45.576 47.671 49.703	52.734 55.937 59.049	59.008 63.449 67.884	66.053 72.206 78.713	72.395 80.477 89.801
1.0	0 0.0005 0.001	19.149 19.187 19.224	23.805 23.876 23.943	27.689 27.798 27.899	34.157 34.355 34.530	42.032 42.388 42.674	48.646 49.181 49.561	56.273 57.058 57.499	62.982 64.025 64.391	70.475 71.834 71.745	77.245 78.888 77.541
1.1	0 0.0005 0.001	16.413 16.328 16.239	20.404 20.249 20.081	23.734 23.492 23.226	29.277 28.826 28.300	36.028 35.170 34.078	41.699 40.327 38.412	48.235 46.001 42.443	53.985 50.673 44.560	60.408 55.401 43.930	66.210 59.050 37.290
1.3	0 0.0005 0.001	10.257 10.093 9.922	12.752 12.450 12.130	14.832 14.366 13.861	18.297 17.427 16.444	22.516 20.874 18.881	26.060 23.454 20.026	30.144 25.952 19.676	33.738 27.592 16.639	37.752 28.581 -	41.378 28.401 -
1.5	0 0.0005 0.001	7.090 6.925 6.753	8.814 8.511 8.190	10.252 9.784 9.277	12.647 11.775 10.783	15.562 13.915 11.883	18.012 15.392 11.829	20.835 16.604 9.682	23.319 17.082 -	26.093 16.676 -	28.600 14.984 -

$x_\alpha = 0.1$ $x_0 = 0.5$ $r_\alpha^2 = 0.25$

TABLE 29 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	4.535	5.638	6.558	8.090	9.955	11.522	13.328	14.917	16.691	18.295
	0.0005										
	0.001										
0.3	0	5.156	6.410	7.456	9.197	11.318	13.099	15 152	16.959	18.976	20.799
	0.0005										
	0.001										
0.5	0	6.551	8.143	9.472	11.685	14.379	16.642	19.251	21.546	24.109	26.425
	0.0005										
	0.001										
0.7	0	9.757	12.130	14.109	17.404	21.417	24.789	28.674	32.092	35.910	39.359
	0.0005										
	0.001										
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

$x_\alpha = 0.1$	$x_0 = 0.5$	$r_\alpha^2 = 0.36$

TABLE 30 $\frac{\mu b \omega_\alpha}{a}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	10.171	12.546	14.539	17.869	21.937	25.360	29.309	32.785	36.670	40.182
0.3	0 0.0005 0.001										
0.5	0 0.0005 0.001										
0.7	0 0.0005 0.001										
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_\alpha = 0.1$ | $x_0 = 0.55$ | $r_\alpha^2 = 0.09$

TABLE 31 $\frac{\mu b \omega_\alpha}{a}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	8.196	10.110	11.716	14.400	17.677	20.436	23.618	26.419	29.550	32.379
0.3	0 0.0005 0.001										
0.5	0 0.0005 0.001										
0.7	0 0.0005 0.001										
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_\alpha = 0.1$	$x_0 = 0.55$	$r_\alpha^2 = 0.16$

TABLE 32 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$(\frac{\omega_h}{\omega_a})$	δ_i/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	7.098	8.756	10.147	12.471	15.310	17.699	20.454	22.881	25.592	28.042
0.3	0 0.0005 0.001										
0.5	0 0.0005 0.001										
0.7	0 0.0005 0.001										
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$X_a = 0.1$ $\quad X_0 = 0.55$ $\quad r_a^2 = 0.25$

TABLE 33 $\frac{\mu b \omega_a}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_a}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	6.424	7.924	9.182	11.286	13.855	16.017	18.511	20.707	23.160	25.378
0.3	0 0.0005 0.001										
0.5	0 0.0005 0.001										
0.7	0 0.0005 0.001										
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_a = 0.1$	$x_0 = 0.55$	$r_a^2 = 0.36$

TABLE 34 $\frac{\mu b \omega_a}{a}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
0.3	0 0.0005 0.001	* - -	* - 1.833	* - 4.306	* 3.542 8.191	* 7.912 13.617	* 11.829 18.935	* 16.897 25.974	* 21.902 32.995	* 28.122 41.766	* 34.325 50.542
0.5	0 0.0005 0.001	6.316 6.784 7.222	7.986 8.808 9.559	9.362 10.592 11.692	11.637 13.806 15.674	14.389 18.197 21.325	16.694 22.342 26.802	19.344 27.672 33.973	21.673 32.875 41.058	24.271 39.276 49.845	26.617 45.603 58.583
0.7	0 0.0005 0.001	9.522 9.827 10.123	11.848 12.397 12.921	13.788 14.620 15.405	17.016 18.513 19.890	20.945 23.627 26.015	24.246 28.285 31.179	28.049 34.107 39.199	31.394 39.662 46.449	35.131 46.374 55.438	38.507 52.923 64.513
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_\alpha = 0.2$ $x_0 = 0.35$ $r_\alpha^2 = 0.09$

TABLE 35 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *	* * *
0.3	0 0.0005 0.001	* - -	* - -	* - -	* - 4.740	* 2.655 9.632	* 6.972 14.201	* 11.566 20.187	* 15.909 26.146	* 21.229 33.602	* 26.503 41.090
0.5	0 0.0005 0.001	3.818 4.373 4.864	4.958 5.899 8.639	5.880 7.262 8.416	7.388 9.767 11.662	9.197 13.276 16.346	10.705 16.653 20.934	12.434 21.055 26.972	13.950 25.393 32.950	15.640 30.760 40.360	17.164 36.086 47.707
0.7	0 0.0005 0.001	8.333 8.621 8.898	10.388 10.903 11.391	12.099 12.879 13.605	14.945 16.340 17.602	18.406 20.893 23.052	21.312 25.041 28.165	24.660 30.222 34.688	27.604 35.154 40.997	30.893 41.092 48.690	33.864 46.857 56.249
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_\alpha = 0.2$ $x_0 = 0.35$ $r_\alpha^2 = 0.16$

TABLE 36 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	*	*	*	*	*	*	*	*	*	*
	0.001	*	*	*	*	*	*	*	*	*	*
0.3	0	*	*	*	*	*	*	*	*	*	*
	0.0005	-	-	-	-	-	4.386	8.937	12.947	17.774	22.531
	0.001	-	-	-	2.870	7.669	11.835	17.235	22.603	29.334	36.119
0.5	0	2.033	2.877	3.524	4.550	5.756	6.750	7.883	8.872	9.971	10.961
	0.0005	2.798	4.073	5.214	7.342	10.380	13.343	17.242	21.107	25.912	30.693
	0.001	3.394	4.988	6.475	9.326	13.487	17.589	23.013	28.401	35.096	41.750
0.7	0	7.403	9.246	10.779	13.325	16.420	19.019	22.010	24.642	27.580	30.234
	0.0005	7.683	9.744	11.530	14.666	18.799	22.572	27.288	31.776	37.173	42.400
	0.001	7.950	10.212	12.223	15.860	20.823	25.473	31.386	37.074	43.946	50.608
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

$x_\alpha = 0.2$ $x_0 = 0.35$ $r_\alpha^2 = 0.25$

TABLE 37 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	*	*	*	*	*	*	*	*	*	*
0.3	0 0.0005 0.001	*	*	*	*	*	*	*	*	*	*
0.5	0 0.0005 0.001	-	0.876	1.472	2.229	3.028	3.656	4.355	4.956	5.618	6.210
0.7	0 0.0005 0.001	6.708	8.394	9.793	12.117	14.939	17.307	20.034	22.431	25.109	27.527
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_\alpha = 0.2$ $x_0 = 0.35$ $r_\alpha^2 = 0.36$

TABLE 38 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	1.370	3.089	4.503	7.138	10.953	14.718	19.708	24.683	30.893	37.097
	0.001	2.831	4.833	6.696	10.306	15.630	20.919	27.951	34.974	43.744	52.511
0.3	0	5.780	7.283	8.526	10.581	13.072	15.159	17.559	19.669	22.024	24.151
	0.0005	6.297	8.191	9.881	12.964	17.234	21.302	26.572	31.742	38.122	44.444
	0.001	6.774	9.006	11.070	14.967	20.554	26.005	33.167	40.260	49.063	57.815
0.5	0	9.625	11.957	13.904	17.146	21.094	24.413	28.237	31.601	35.360	38.755
	0.0005	9.957	12.555	14.811	18.778	24.017	28.811	34.828	40.586	47.564	54.383
	0.001	10.279	13.125	15.664	20.273	26.605	32.596	40.313	47.862	57.177	66.439
0.7	0	11.894	14.723	17.090	21.039	25.856	29.906	34.577	38.688	43.280	47.305
	0.0005	12.154	15.195	17.810	22.343	28.210	33.474	39.966	46.091	53.429	60.544
	0.001	12.409	15.652	18.500	23.571	30.374	36.693	44.742	52.912	62.370	72.401
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

$x_\alpha = 0.2$ $x_0 = 0.4$ $r_\alpha^2 = 0.09$

TABLE 39 $\frac{\mu b \omega_\alpha}{a}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	*	*	*	*	*	*	*	*	*	*
	0.0005	1.117	2.520	3.673	5.822	8.934	12.004	16.074	20.132	25.196	30.256
	0.001	2.309	3.942	5.461	8.405	12.748	17.062	22.797	28.525	35.678	42.828
0.3	0	3.889	4.955	5.828	7.268	9.006	10.459	12.128	13.594	15.229	16.705
	0.0005	4.404	5.844	7.144	9.548	12.931	16.194	20.452	24.652	29.852	35.014
	0.001	4.864	6.613	8.248	11.371	15.895	20.333	26.182	31.980	39.177	46.327
0.5	0	7.273	9.058	10.546	13.021	16.032	18.561	21.475	24.038	26.900	29.486
	0.0005	7.583	9.613	11.384	14.519	18.597	22.546	27.403	32.068	37.727	43.255
	0.001	7.880	10.134	12.158	15.858	20.977	25.835	32.091	38.186	45.650	52.985
0.7	0	10.499	13.005	15.101	18.597	22.860	26.444	30.577	34.213	38.277	41.948
	0.0005	10.728	13.419	15.730	19.731	24.897	29.518	35.197	40.528	46.878	52.992
	0.001	10.951	13.815	16.326	20.782	26.727	32.207	39.120	45.770	53.894	61.963
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

$x_\alpha = 0.2$ | $x_0 = 0.4$ | $r_\alpha^2 = 0.16$

TABLE 40 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	* 0.978 2.022	* 2.207 3.452	* 3.217 4.783	* 5.099 7.362	* 7.824 11.165	* 10.513 14.943	* 14.078 19.966	* 17.632 24.982	* 22.067 31.248	* 26.499 37.510
0.3	0 0.0005 0.001	2.955 3.472 3.921	3.807 4.687 5.424	4.500 5.790 6.837	5.636 7.848 9.552	7.003 10.772 13.506	8.143 13.610 17.395	9.452 17.328 22.527	10.601 21.004 27.618	11.881 25.562 33.937	13.037 30.091 40.212
0.5	0 0.0005 0.001	5.917 6.218 6.504	7.387 7.924 8.422	8.610 9.419 10.155	10.642 12.081 13.342	13.113 15.656 17.782	15.187 18.975 22.013	17.575 23.183 27.469	19.676 27.238 32.783	22.022 32.168 39.279	24.141 36.989 45.642
0.7	0 0.0005 0.001	9.443 9.651 9.851	11.705 12.078 12.434	13.595 14.162 14.694	16.747 17.766 18.697	20.590 22.413 24.016	23.821 26.562 28.892	27.545 31.645 34.993	30.823 36.401 40.800	34.485 42.039 47.788	37.793 47.438 54.578
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_\alpha = 0.2$ $x_0 = 0.4$ $r_\alpha^2 = 0.25$

TABLE 41 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$(\frac{\omega_h}{\omega_\alpha})$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	*	*	*	*	*	*	*	*	*	*
0.3	0 0.0005 0.001	2.431	3.163	3.756	4.722	5.881	6.847	7.955	8.925	10.008	10.984
0.5	0 0.0005 0.001	5.093	6.373	7.435	9.199	11.341	13.139	15.208	17.028	19.061	20.896
0.7	0 0.0005 0.001	8.679	10.763	12.504	15.408	18.947	21.921	25.350	28.367	31.738	34.784
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

x_α = 0.2	x_0 = 0.4	r_α^2 = 0.36

TABLE 42 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	6.832	8.493	9.879	12.186	14.996	17.357	20.077	22.471	25.144	27.559
	0.0005	7.262	9.261	11.037	14.247	18.636	22.773	28.087	33.269	39.636	45.923
	0.001	7.668	9.969	12.083	16.038	21.655	27.095	34.212	41.240	49.947	58.595
0.3	0	9.263	11.475	13.324	16.409	20.170	23.333	26.979	30.188	33.773	37.013
	0.0005	9.598	12.078	14.240	18.055	23.114	27.759	33.602	39.203	45.996	52.635
	0.001	9.921	12.650	15.096	19.554	25.700	31.528	39.040	46.379	55.404	64.320
0.5	0	12.177	15.053	17.462	21.484	26.392	30.520	35.281	39.472	44.155	48.387
	0.0005	12.454	15.557	18.231	22.877	28.907	34.334	41.042	47.384	54.992	62.373
	0.001	12.725	16.044	18.968	24.189	31.219	37.767	46.114	54.229	64.228	74.205
0.7	0	13.967	17.248	19.998	24.592	30.199	34.918	40.360	45.181	50.505	55.343
	0.0005	14.201	17.675	20.652	25.782	32.360	38.209	45.363	52.063	60.046	67.758
	0.001	14.431	18.092	21.286	26.922	34.399	41.283	50.004	58.495	69.115	80.141
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

x_α = 0.2 $\quad$ x_0 = 0.45 $\quad$ r_α^2 = 0.09

TABLE 43 $\frac{\mu b \omega_\alpha}{a}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	5.561	6.913	8.041	9.920	12.207	14.129	16.343	18.291	20.467	22.433
	0.0005	5.909	7.534	8.973	11.582	15.139	18.488	22.783	26.963	32.091	37.144
	0.001	6.236	8.104	9.818	13.021	17.558	21.942	27.661	33.293	40.248	47.136
0.3	0	7.102	8.804	10.227	12.599	15.491	17.922	20.724	23.190	25.945	28.434
	0.0005	7.390	9.321	11.010	14.002	17.990	21.665	26.301	30.753	36.155	41.434
	0.001	7.666	9.808	11.735	15.260	20.141	24.775	30.747	36.718	43.159	50.750
0.5	0	9.544	11.806	13.699	16.859	20.714	23.957	27.696	30.987	34.664	37.987
	0.0005	9.778	12.229	14.342	18.020	22.799	27.102	32.418	37.436	43.437	49.233
	0.001	10.006	12.634	14.951	19.093	24.664	29.835	36.387	42.698	50.374	57.895
0.7	0	12.272	15.158	17.578	21.619	26.551	30.701	35.487	39.701	44.409	48.663
	0.0005	12.466	15.512	18.118	22.600	28.326	33.396	39.570	45.323	52.140	58.684
	0.001	12.657	15.856	18.639	23.530	29.977	35.867	43.263	50.383	59.140	67.966
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

x_α = 0.2	x_0 = 0.45	r_α^2 = 0.16

TABLE 44 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$(\frac{\omega_h}{\omega_\alpha})$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	4.862	6.044	7.030	8.672	10.672	12.352	14.288	15.991	17.894	19.612
	0.0005	5.164	6.582	7.841	10.113	13.211	16.124	19.853	23.478	27.916	32.282
	0.001	5.447	7.076	8.569	11.355	15.294	19.091	24.032	28.883	34.858	40.755
0.3	0	5.999	7.441	8.645	10.652	13.098	15.155	17 526	19.612	21.942	24.048
	0.0005	6.258	7.905	9.347	11.908	15.329	18.489	22.478	26.311	30.959	35.498
	0.001	6.506	8.339	9.992	13.023	17.223	21.212	26.346	31.344	37.459	43.461
0.5	0	8.047	9.958	11.557	14.226	17.482	20.220	23.377	26.155	29.260	32.065
	0.0005	8.257	10.337	12.133	15 261	19.334	23.005	27.542	31.822	36.936	41.864
	0.001	8.461	10.698	12.673	16.206	20.961	25.369	30.939	36.283	42.746	49.033
0.7	0	11.003	13.595	15.767	19.394	23.820	27.544	31.839	35.620	39.844	43.662
	0.0005	11.169	13.894	16.223	20.218	25.304	29.791	35.226	40.262	46.189	51.834
	0.001	11.330	14.183	16.658	20.989	26.658	31.791	38.168	44.220	51.520	58.668
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

$x_\alpha = 0.2$ $\quad x_0 = 0.45$ $\quad r_\alpha^2 = 0.25$

TABLE 45 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	4.436	5.515	6.414	7.913	9.737	11.270	13.036	14.590	16.326	17.895
0.3	0 0.0005 0.001	5.361	6.650	7.728	9.523	11.712	13.551	15.671	17.537	19.621	21.504
0.5	0 0.0005 0.001	7.260	8.842	10.264	12.636	15.529	17.963	20.768	23.237	25.996	28.488
0.7	0 0.0005 0.001	10.101	12.483	14.478	17.810	21.876	25.297	29.242	32.715	36.596	40.103
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

x_α = 0.2	x_0 = 0.45	r_α^2 = 0.36

TABLE 46 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	g/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	9.828	12.124	14.049	17.268	21.198	24.506	28.322	31.682	35.436	38.829
	0.0005	10.124	12.659	14.864	18.737	23.837	28.485	34.296	39.838	46.529	53.048
	0.001	10.410	13.170	15.633	20.091	26.191	31.936	39.306	46.481	55.284	63.966
0.3	0	11.769	14.518	16.824	20.678	25.384	29.346	33.915	37.938	42.433	46.497
	0.0005	12.035	15.000	17.559	22.010	27.788	32.986	39.406	45.467	52.724	59.744
	0.001	12.294	15.466	18.263	23.259	29.982	36.230	44.165	51.831	61.188	70.386
0.5	0	14.380	17.739	20.556	25.265	31.016	35.856	41.439	46.355	51.848	56.812
	0.0005	14.629	18.194	21.253	26.534	33.320	39.366	46.775	53.726	62.015	70.020
	0.001	14.875	18.638	21.929	27.751	35.496	42.640	51.690	60.463	71.281	82.130
0.7	0	15.858	19.563	22.670	27.863	34.205	39.542	45.699	51.120	57.178	62.653
	0.0005	16.076	19.962	23.283	28.984	36.249	42.667	50.469	57.735	66.349	74.636
	0.001	16.291	20.354	23.883	30.071	38.211	45.649	55.014	64.089	75.398	87.123
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

$x_\alpha = 0.2$	$x_0 = 0.5$	$r_\alpha^2 = 0.09$

TABLE 47 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	7.957	9.816	11.375	13.981	17.163	19.841	22.931	25.651	28.690	31.438
	0.0005	8.190	10.237	12.015	15.135	19.232	22.958	27.602	32.020	37.338	42.504
	0.001	8.415	10.638	12.618	16.193	21.065	25.636	31.475	37.136	44.053	50.848
0.3	0	9.189	11.336	13.136	16.145	19.820	22.913	26.481	29.622	33.132	36.304
	0.0005	9.402	11.722	13.724	17.208	21.731	25.800	30.822	35.557	41.217	46.680
	0.001	9.610	12.092	14.282	18.194	23.451	28.327	34.500	40.444	47.667	54.734
0.5	0	11.331	13.978	16.197	19.908	24.439	28.253	32.652	36.526	40.854	44.766
	0.0005	11.524	14.328	16.733	20.880	26.197	30.919	36.683	42.064	48.443	54.561
	0.001	11.713	14.669	17.249	21.798	27.818	33.328	40.238	46.851	54.866	62.714
0.7	0	13.822	17.050	19.758	24.285	29.812	34.464	39.831	44.555	49.835	54.607
	0.0005	13.999	17.374	20.254	25.190	31.462	36.986	43.681	49.898	57.250	64.304
	0.001	14.173	17.692	20.740	26.069	33.051	39.404	47.377	55.077	64.621	74.384
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

$x_\alpha = 0.2$	$x_0 = 0.5$	$r_\alpha^2 = 0.16$

TABLE 48 $\frac{\mu b \omega_\alpha}{a}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_a}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0	6.922	8.539	9.895	12.162	14.930	17.260	19.948	23.176	24.958	27.348
	0.0005	7.119	8.895	10.437	13.137	16.676	19.887	23.878	27.664	32.208	36.610
	0.001	7.310	9.234	10.945	14.026	18.211	22.120	27.094	31.897	37.740	43.456
0.3	0	7.837	9.668	11.203	13.769	16.904	19.541	22.584	25.263	28.257	30.963
	0.0005	8.020	9.998	11.706	14.676	18.530	21.993	26.262	30.280	35.073	39.688
	0.001	8.197	10.314	12.180	15.510	19.977	24.109	29.323	34.325	40.379	46.279
0.5	0	9.604	11.847	13.728	16.873	20.714	23.946	27.675	30.958	34.627	37.942
	0.0005	9.765	12.141	14.176	17.683	22.172	26.152	30.997	35.507	40.833	45.920
	0.001	9.924	12.424	14.603	18.439	23.495	28.102	33.847	39.306	45.869	52.236
0.7	0	12.283	15.152	17.558	21.581	26.493	30.627	35.396	39.594	44.286	48.527
	0.0005	12.424	15.410	17.953	22.298	27.795	32.612	38.414	43.765	50.045	56.016
	0.001	12.564	15.662	18.336	22.988	29.029	34.471	41.214	47.623	55.391	63.068
0.8	0										
	0.0005										
	0.001										
0.9	0										
	0.0005										
	0.001										
1.0	0										
	0.0005										
	0.001										
1.1	0										
	0.0005										
	0.001										
1.3	0										
	0.0005										
	0.001										
1.5	0										
	0.0005										
	0.001										

$x_a = 0.2$ | $x_0 = 0.50$ | $r_a^2 = 0.25$

TABLE 49 $\frac{\mu b \omega_a}{a}$ **FOR BENDING-TORSION FLUTTER**

$\left(\frac{\omega_h}{\omega_\alpha}\right)$	δ/μ \ μM	40	60	80	120	180	240	320	400	500	600
0	0 0.0005 0.001	6.289	7.758	8.990	11.049	13.564	15.681	18.123	20.273	22.675	24.846
0.3	0 0.0005 0.001	7.037	8.681	10.060	12.365	15.179	17.548	20.280	22.686	25.374	27.804
0.5	0 0.0005 0.001	8.560	10.559	12.236	15.040	18.463	21.344	24.667	27.593	30.863	33.818
0.7	0 0.0005 0.001	11.196	13.812	16.005	19.671	24.149	27.917	32.264	36.092	40.369	44.234
0.8	0 0.0005 0.001										
0.9	0 0.0005 0.001										
1.0	0 0.0005 0.001										
1.1	0 0.0005 0.001										
1.3	0 0.0005 0.001										
1.5	0 0.0005 0.001										

$x_\alpha = 0.2$ $\quad x_0 = 0.50$ $\quad r_\alpha^2 = 0.36$

TABLE 50 $\frac{\mu b \omega_\alpha}{a}$ FOR BENDING-TORSION FLUTTER

ω_β/ω_h	δ/μ \ μ_M	40	80	120	240	400
0	0	- -	- -	48.113 46.406	70.061 63.702	91.123 81.612
	0.001	- -	- -	- -	58.861 55.899	65.451 62.534
0.3	0	- -	- -	- -	73.290 66.918	95.421 85.645
	0.001	- -	- -	- -	61.500 58.792	68.482 65.677
0.4	0	- -	- -	- -	76.128 69.793	99.217 89.232
	0.001	- -	- -	- -	63.784 61.411	71.144 68.488
0.5	0	- -	- -	- -	80.295 74.111	104.831 94.588
	0.001	- -	- -	- -	66.991 65.488	75.037 72.727
0.6	0	- -	- -	- -	86.391 80.720	113.176 102.672
	0.001	- -	- -	- -	- -	80.563 79.381
0.7	0	- -	- -	- -	95.354 91.774	126.136 115.605
	0.001	- -	- -	- -	- -	- -
0.8	0	- -	- -	- -	- -	148.183 139.407
	0.001	- -	- -	- -	- -	- -
	$x_1 = 0.8$		$x_\beta = 0.0$		$r_\beta^2 = 0.00196$	

TABLE 51 $\frac{\mu b \omega_h}{a}$ **FOR BENDING-AILERON FLUTTER**

No real solutions for values of $\frac{\omega_\beta}{\omega_h}$ above 0.8 for the range of μ_M considered.

No Real Solutions

$x_1 = 0.8$	$x_\beta = 0.01$	$r_\beta^2 = 0.001,96$

TABLE 52 $\frac{\mu b \omega_h}{a}$ **FOR BENDING-AILERON FLUTTER**

No Real Solutions		
$x_1 = 0.8$	$x_\beta = 0.014$	$r_\beta^2 = 0.001,96$

TABLE 53 $\frac{\mu b \omega_h}{a}$ FOR BENDING-AILERON FLUTTER

ω_β/ω_h	δ/μ \ μM	40	80	120	240	400
0	0	- -	31.061 29.342	38.738 35.271	55.484 49.222	71.943 63.254
	0.001	- -	29.287 28.470	35.730 33.320	46.716 43.101	51.752 48.396
0.3	0	- -	32.275 31.031	40.482 37.089	58.094 51.660	75.367 66.352
	0.001	- -	- -	37.305 35.070	48.895 45.252	54.196 50.784
0.4	0	- -	- -	42.004 38.724	60.398 53.830	78.395 69.105
	0.001	- -	- -	38.664 36.657	50.816 47.170	56.355 52.909
0.5	0	- -	- -	44.214 41.203	63.804 57.071	82.885 73.205
	0.001	- -	- -	40.571 39.125	53.646 50.043	59.547 56.081
0.6	0	- -	- -	47.339 45.098	68.862 61.969	89.581 79.375
	0.001	- -	- -	- -	57.822 54.409	64.287 60.875
0.7	0	- -	- -	- -	76.701 69.816	100.060 89.176
	0.001	- -	- -	- -	64.151 61.542	71.620 68.570
0.8	0	- -	- -	- -	89.955 84.334	118.330 106.827
	0.001	- -	- -	- -	- -	- -
0.9		- -	- -	- -	- -	158.176 151.420
	0.001	- -	- -	- -	- -	- -
1.0	0	- -	- -	- -	- -	- -
	0.001	- -	- -	- -	- -	- -
	$x_1 = 0.8$		$x_\beta = 0$		$r_\beta^2 = 0.00324$	

TABLE 54 $\frac{\mu b \omega_h}{a}$ FOR BENDING-AILERON FLUTTER

ω_β/ω_h	δ/μ \ μ_M	40	80	120	240	400
0	0	24.927 18.570	35.735 25.860	43.952 31.518	62.415 44.362	80.708 57.164
	0.001	24.275 18.187	33.840 24.774	40.416 29.491	52.022 38.265	57.060 42.666
0.3	0	25.782 19.629	37.052 27.266	45.604 33.209	64.803 46.711	83.817 60.176
	0.001	25.110 19.220	35.091 26.112	41.943 31.058	54.030 40.253	59.286 44.847
0.4	0	26.381 20.651	38.030 28.598	46.847 34.802	66.620 48.916	86.191 62.998
	0.001	25.697 20.217	36.027 27.378	43.102 32.531	55.583 42.111	61.029 46.877
0.5	0	26.849 22.444	39.031 30.820	48.176 37.432	68.629 52.520	88.848 67.596
	0.001	26.161 21.965	37.001 29.485	44.369 34.955	57.368 45.130	63.095 50.150
0.6	0	- -	38.013 36.116	47.890 42.974	68.938 59.671	89.528 76.560
	0.001	- -	36.057 34.548	44.233 40.043	57.962 51.042	64.157 56.389
0.7	0	- -	- -	- -	- -	- -
	0.001	- -	- -	- -	- -	- -
0.8	0	- -	- -	- -	- -	- -
	0.001	- -	- -	- -	- -	- -
	$x_1 = 0.8$		$x_\beta = 0.01$		$r_\beta^2 = 0.00324$	

TABLE 55 $\frac{\mu b \omega_h}{a}$ **FOR BENDING-AILERON FLUTTER**

No real solutions for values of $\frac{\omega_\beta}{\omega_h}$ **above** 0.8 **for the range of** μ_M **considered**

ω_β/ω_h	g/μ \ μM	40	80	120	240	400
0	0	23.049 19.606	33.366 27.035	41.137 32.871	58.539 46.169	75.755 59.447
	0.001	22.465 19.185	31.652 25.856	37.926 30.682	49.043 39.635	54.006 44.047
0.3	0	- -	32.806 29.751	40.758 35.896	58.310 50.150	75.589 64.461
	0.001	- -	31.159 28.430	37.654 33.457	49.049 42.929	54.232 47.549
0.4	0	- -	- -	- -	- -	- -
	0.001	- -	- -	- -	- -	- -
	$x_1 = 0.8$		$x_\beta = 0.014$		$r_\beta^2 = 0.00324$	

TABLE 56 $\frac{\mu b \omega_h}{a}$ **FOR BENDING-AILERON FLUTTER**

No real solutions for values of $\frac{\omega_\beta}{\omega_h}$ **above** 0.4

$\omega_\beta/\omega_\alpha$	g/μ \ μM	40	80	120	240	400
0	0	28.392 22.360	40.919 30.999	50.402 37.736	71.671 53.057	92.725 68.341
	0.001	27.730 22.036	38.988 30.213	46.788 36.257	60.953 48.451	68.050 56.781
0.3	0	30.218 23.266	43.567 32.242	53.673 39.243	76.334 55.167	98.764 71.054
	0.001	29.519 22.968	41.521 31.398	49.838 37.659	64.946 50.256	72.538 58.774
0.4	0	31.854 24.076	45.948 33.348	56.616 40.583	80.533 57.041	104.204 73.463
	0.001	31.121 23.759	43.793 32.455	52.571 38.910	68.511 51.872	76.507 60.581
0.5	0	34.313 25.292	49.540 35.000	61.060 42.581	86.880 59.833	112.429 77.049
	0.001	33.525 24.947	47.211 34.037	56.683 40.781	73.855 54.293	82.409 63.308
0.6	0	38.043 27.143	55.019 37.498	67.849 45.596	96.589 64.035	125.018 82.445
	0.001	37.166 26.756	52.409 36.430	62.934 43.608	81.942 57.957	91.256 67.457
0.7	0	43.934 30.156	63.760 41.516	78.709 50.429	112.162 70.753	145.231 91.059
	0.001	42.903 29.703	60.664 40.283	72.866 48.146	94.722 63.829	105.077 74.123
0.8	0	53.483 36.007	78.366 49.098	97.000 59.479	138.573 83.241	179.600 107.029
	0.001	52.185 35.420	74.384 47.547	89.448 56.636	115.989 74.736	127.788 86.474
0.85	0	58.777 42.325		108.905 68.437		
	0.001	57.349 41.580	83.081 54.841	100.237 65.016	130.108 85.328	142.933 98.374
0.9	0	- -	- -	- -	154.383 128.525	202.980 162.901
	0.001	- -	- -	- -	128.608 115.041	142.141 131.861

$x_1 = 0.8$ | $x_\beta = 0$ | $g^2 = 0.001,96$

$x_\alpha = 0.4$ | $r_\alpha^2 = 0.36$

TABLE 57 $\frac{\mu b \omega_\alpha}{a}$ FOR TORSION-AILERON FLUTTER

No real solutions at $\frac{\omega_\beta}{\omega_\alpha} = 1.0$

No real solutions

$x_1 = 0.8$	$x_\beta = 0.01$	$r_\beta^2 = 0.001,96$
$x_o = 0.4$		$r_\alpha^2 = 0.36$

TABLE 58 $\frac{\mu b \omega_\alpha}{a}$ **FOR TORSION-AILERON FLUTTER**

No real solutions

$x_1 = 0.8$	$x_\beta = 0.014$	$r_\beta^2 = 0.001,96$

$x_o = 0.4$ $r_\alpha^2 = 0.36$

TABLE 59 $\frac{\mu b \omega_a}{a}$ **FOR TORSION-AILERON FLUTTER**

ω_β/ω_a	δ/μ \ μ_M	40	80	120	240	400
0	0	22.809 17.117	32.612 23.917	40.081 21.180	56.875 41.113	78.319 52.998
	0.001	22.290 16.926	31.110 23.367	37.276 28.141	48.587 37.851	54.503 44.754
0.3	0	24.283 17.772	34.731 24.825	42.689 30.285	60.582 42.664	78.319 54.996
	0.001	23.735 17.565	33.139 24.233	39.715 29.169	51.789 39.175	58.139 46.621
0.4	0	25.603 18.354	36.631 25.630	45.029 31.264	63.911 44.039	82.262 56.765
	0.001	25.027 18.134	34.955 25.003	41.895 30.083	54.637 40.359	61.339 47.530
0.5	0	27.584 19.222	39.488 26.827	48.551 32.717	68.922 46.078	89.110 59.389
	0.001	26.964 18.984	37.677 26.150	45.162 31.446	58.887 42.130	66.069 49.528
0.6	0	30.580 20.529	43.821 28.621	53.895 34.895	76.534 49.128	98.965 63.312
	0.001	29.887 20.264	41.792 27.873	50.095 33.492	65.268 44.798	73.097 52.561
0.7	0	35.279 22.616	50.657 31.469	62.342 38.342	88.582 53.948	114.573 69.507
	0.001	34.462 22.309	48.252 30.610	57.832 36.738	75.206 49.033	83.895 57.402
0.8	0	42.853 26.490	61.838 36.675	76.219 44.618	108.458 62.688	140.360 80.721
	0.001	41.813 26.105	58.748 35.617	70.409 42.654	91.232 56.731	100.999 66.220
0.85	0	47.407 30.278				
	0.001	46.227 29.815	65.357 40.369	78.414 48.222	101.466 63.929	111.796 74.463
0.9	0	- -	69.280 53.496	86.653 64.132	124.814 89.017	162.229 114.129
	0.001	- -	65.689 51.866	79.805 61.160	104.156 80.270	114.337 93.590

$X_1 = 0.8$	$x_\beta = 0$	$\bar{r}_\beta^2 = 0.003,24$

$x_a = 0.4$ $r_a^2 = 0.36$

TABLE 60 $\frac{\mu b \omega_a}{a}$ **FOR TORSION-AILERON FLUTTER**

No real solutions at $\frac{\omega_\beta}{\omega_a} = 1.0$

$\omega_\beta/\omega_\alpha$	g/μ \ μM	40	80	120	240	400
0	0	25.995 15.373	37.022 21.561	45.446 26.335	64.417 37.144	83.238 47.901
	0.001	25.339 15.146	35.124 20.917	41.909 25.132	54.037 33.491	59.704 39.088
0.3	0	26.587 16.226	37.912 22.728	46.557 27.750	66.017 39.124	85.318 50.447
	0.001	25.919 15.980	35.974 22.036	42.942 26.457	55.398 35.210	61.229 41.034
0.4	0	26.789 17.069	38.259 23.873	47.006 29.134	66.683 41.056	86.194 59.929
	0.001	26.123 16.805	36.318 23.132	43.382 27.754	56.024 36.889	61.977 42.936
0.5	0	26.397 18.592	37.851 25.900	46.561 31.569	66.128 44.437	85.514 57.262
	0.001	25.756 18.297	35.972 25.077	43.041 30.040	55.731 39.842	61.784 46.303
0.6	0	- -	- -	- -	58.495 54.126	76.198 63.413
	0.001	- -	- -	- -	- -	- -
	$x_1 = 0.8$		$x_\beta = 0.01$		$r_\beta^2 = 0.003,24$	
	$x_o = 0.4$				$r_\alpha^2 = 0.36$	

TABLE 61 $\frac{\mu b \omega_\alpha}{a}$ **FOR TORSION-AILERON FLUTTER**

No real solutions for values of $\frac{\omega_\beta}{\omega_\alpha}$ **above** 0.6

ω_β/ω_a	δ/μ \ μM	40	80	120	240	400
0	0	23.123 16.133	33.051 22.543	40.617 27.503	57.633 38.748	74.502 49.948
	0.001	22.576 15.869	31.452 21.804	37.627 26.130	48.814 34.624	54.403 40.127
0.3	0	21.763 17.992	31.421 24.890	38.717 30.286	55.071 42.565	71.256 54.819
	0.001	21.629 17.689	29.957 24.052	35.966 28.734	46.901 37.933	52.509 48.852
	$x_1 = 0.8$		$x_\beta = 0.014$		$r_\beta^2 = 0.003,24$	

$x_o = 0.4$ $r_\alpha^2 = 0.36$

TABLE 62 $\frac{\mu b \omega_a}{a}$ FOR TORSION-AILERON FLUTTER

No real solutions for $\frac{\omega_\beta}{\omega_a}$ above 0.3

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The use of the parameters $\mu b\omega_\alpha/a$ and μM to plot a flutter boundary enable one to plot the requirements of the aircraft and the flutter boundary on the same graph. For example, Fig. 2 shows the region

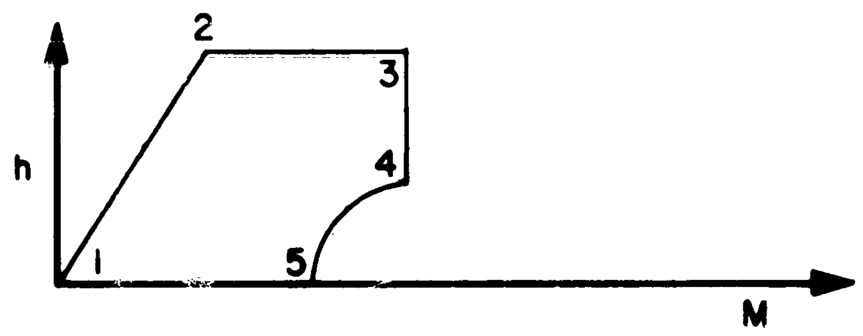

Fig. 2

Graph of Flight Capability of Typical Aircraft in Terms of Altitude and Mach Number

of expected flight capability for a typical aircraft on an altitude versus Mach number plot. After setting the wing configuration (which includes b, ω_α and m_o) of the aircraft involved, Fig. 2 may be redrawn on a $\mu b\omega_\alpha/a$ versus μM plot and should look something like the sketch in Fig. 3.

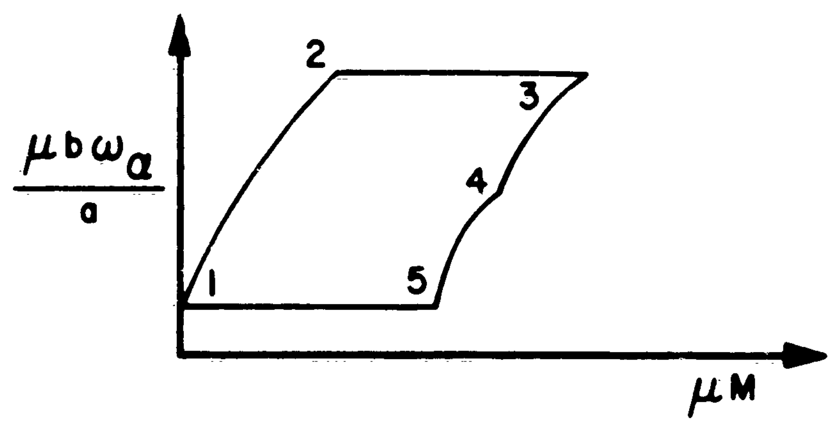

Fig. 3

Flight Capability of Typical Aircraft in Terms of μM and $\mu b\omega_\alpha/a$

Finally, if we superimpose the flutter boundary on the graph of Fig. 3, we will have a sketch similar to the one shown in Fig. 4. This diagram immediately

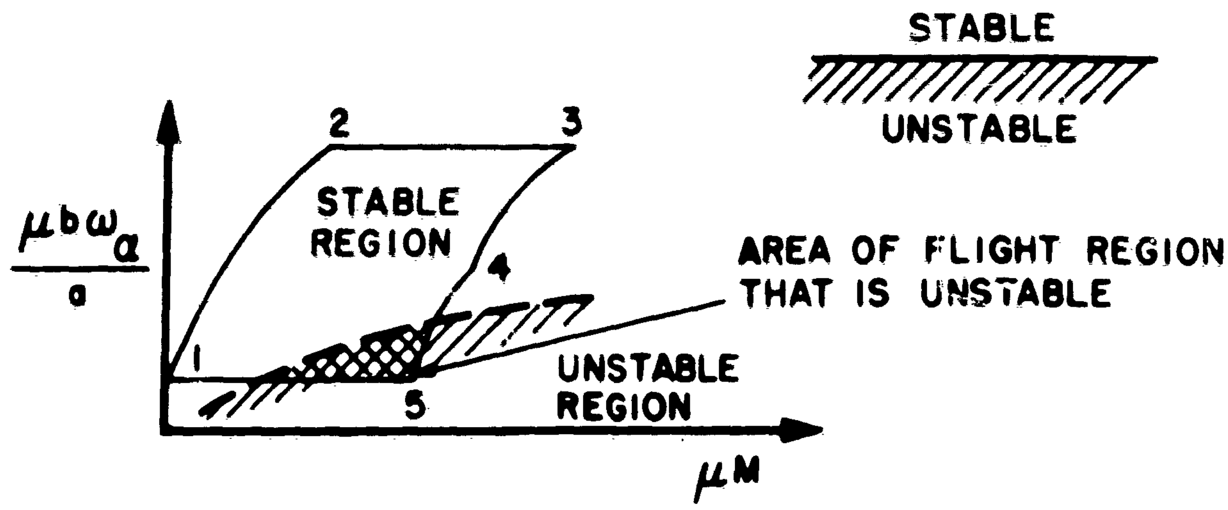

Fig. 4

Flutter Boundary Superimposed on Flight Boundary for Typical Aircraft in Terms of μM and $\mu b\omega_\alpha/a$

shows what part of the required flight region of the specific airplane configuration is unstable.